Hospitalization Rates in Female US Army Recruits Associated With a Screening Program for Chlamydia trachomatis

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Background: **A volunteer program to test non–healthcare-seeking women for genital *Chlamydia trachomatis* infection was instituted at the US Army's largest basic training center and evaluated for its effectiveness in reducing sequelae.**

Goal: **To compare hospitalization rates between women with positive test results for *C trachomatis* and those with negative results, and between women tested and those not tested for *C trachomatis*.**

Study Design: **For this study, 28,074 women who entered the Army in 1996 and 1997 were followed for hospitalizations through December 1998. Of these women, 7053 were tested for *C trachomatis*, and 21,021 were not screened. Hospital admissions were calculated per person-year, and adjusted relative risks were determined.**

Results: **The overall prevalence of *C trachomatis* in the screened group was 9.1%. The relative risk of hospitalization for pelvic inflammatory disease in the screened cohort was 0.94 (95% CI, 0.69–1.29), as compared with those not screened. The relative risk of hospitalization for any reason was 0.94 (95% CI, 0.90–0.99). Among women screened, no difference was found in pelvic inflammatory disease hospitalizations between women with positive test results who were being treated for *C trachomatis* and those with negative test results.**

Conclusions: **The investigated *C trachomatis* intervention program for female Army recruits was associated with a lower overall hospitalization rate in screened volunteers, as compared with unscreened women. The pelvic inflammatory disease hospitalization rate in women with *C trachomatis* who were screened and treated was similar to that observed in uninfected women.**

CHLAMYDIA TRACHOMATIS causes approximately 3 million infections annually in the United States.[1] In most women, symptoms associated with acute infection are infrequent, and if present, generally are mild.[2,3] However, this infection places women at risk for pelvic inflammatory disease (PID) and other sequelae such as ectopic pregnancy, infertility, and chronic pelvic pain.[2] Because women with PID may experience vague symptoms, if any, they may not seek treatment.[2,4] Identification and treatment of women infected with *C trachomatis*, particularly the large subset of those not seeking treatment, are crucial to the prevention of PID and other adverse health outcomes. Once an individual is found to be infected with *C trachomatis*, antibiotic treatment generally is curative. However, the rate at which reinfection occurs may reduce the impact of a single screening effort.[4]

Few evaluations have been conducted to determine the impact of sexually transmitted disease (STD) preventive services on healthcare costs. An Institute of Medicine study group recommended that economic evaluations be performed to improve STD prevention services in managed care organizations.[5] Such assessments require information on the effectiveness of different screening approaches in various populations. Age-based screening for *C trachomatis* was found to be cost-saving, as compared with universal screening, when the occurrence of subsequent PID was modeled using prevalence of infection.[6] Although probability models yield useful estimates of morbidity, direct measurements of outcomes provide data developed from the population of interest and allow for more accurate projections of cost benefits.

Various screening and treatment programs have reduced the prevalence of population-based chlamydia, but the potential impact of a single intervention may be compromised significantly by rapid reinfection.[4] One study found that approximately half of the adolescent girls treated for chlamydia infection were reinfected within 6 to 7 months.[7] In

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contrast, a 1996 study reported that women in a health maintenance organization screening program for *C trachomatis* were protected against the subsequent development of PID for 1 year.[8]

Previously, a program screening 13,204 female Army recruits for *C trachomatis* infections using DNA amplification testing of urine at Fort Jackson, South Carolina, reported a 9.2% prevalence of infection.[9] The purpose of the current study was to evaluate hospitalization rates for sequelae associated with the *C trachomatis* screening program at Fort Jackson.

Methods

Details of the *C trachomatis* screening program for 13,204 female Army recruits have been published.[9] In brief, women exposed to this screening initiative participated in an education program on STDs. Volunteers submitted first-catch urine samples, which were tested for *C trachomatis* by ligase chain reaction (LCX; Abbott Laboratories, Abbott Park, IL). All the women with positive *C trachomatis* test results were notified and treated orally with 1 g of azithromycin. The study cohort consisted of two groups followed for hospitalizations, with rates based on person-years (PY) of exposure. The screened group comprised 7053 (53.4%) of 13,204 women who entered full-time military duty from January 1, 1996 through December 31, 1997. The remaining 6151 women (46.6%) were excluded because they went from basic training at Fort Jackson into the Army Reserve or National Guard and thus were not eligible for standard military healthcare. All the other women (21,021) entering active Army duty as enlisted soldiers during the same period (identified through the Defense Manpower Data Center, Monterey, CA) formed the unscreened group.

All screened and unscreened individuals were followed for hospitalizations from their time of entry into military service, January 1996 through December 1998, or until they left the service, for a maximum possible follow-up period of 3 years. The average follow-up time in days was 585 for the unscreened group, 564 for the screened group with positive *C trachomatis* test results, and 566 for the screened group with negative test results. These average follow-up times were statistically similar between any two groups.

Hospitalization data were obtained from the US Army Patient Administration Services and Biostatistical Administration, Fort Sam Houston, Texas. Study outcomes included hospitalizations for PID (ICD9 codes 614 and 615); ectopic pregnancy (ICD9 code 633); infertility (ICD9 code 628); PID, ectopic pregnancy, and infertility ("combined"); and hospitalizations for any reason. Rates of hospitalization were compared using the Statistical Analysis System (SAS Institute, Cary, NC). Poisson regression was used to determine relative risk for hospitalization and to control for age (<25 years, 25 years or older), race (black, white, other), education (less than high school, high school, post–high school), and aptitude score (<30, 30–63, 64–91, 92–99). The aptitude test completed by military recruit applicants examines multiple areas such as general science, arithmetic reasoning, word knowledge, paragraph comprehension, numerical operations, coding speed, auto and shop information, mathematics knowledge, mechanical comprehension, and electronics information. A higher score correlates with increased aptitude.[10] The Accession Medical Standards Analysis and Research Activity, Walter Reed Army Institute of Research, Silver Spring, Maryland, previously found that individuals with lower aptitude scores are at increased risk for hospital admission during the first 2 years of military service, as compared with those posting higher aptitude scores.[11] Individuals with a high school education or less were found to be at greater risk for a medical discharge from the military in their first year of service, as compared with those who have at least some college education.[11]

TABLE 1. Demographic Data for the Study Cohort

	Screened Group n (%)	Unscreened Group n (%)	*P*
Younger than 25 years	5,960 (85)	16,704 (80)	0.001
Black	2,501 (35)	7,657 (36)	0.350
Education beyond high school	400 (5.7)	1,439 (6.9)	0.001
Aptitude score 64 or more	2,780 (39.4)	7,449 (35.4)	0.001

Results

Among the 7053 women in the screened group, the prevalence of *C trachomatis* infection was 9.1%. Cohort demographic data for the screened group and the 21,021 women in the unscreened group are shown in Table 1. The women in the screened group were significantly younger than those in the unscreened group, and a greater percentage of them scored 64 or more on the aptitude test. More women in the unscreened group had some education beyond high school, but the percentage of women with an education level exceeding high school was small in both groups.

The length of time these women had been infected before entry into the Army is unknown. The average follow-up period for all the groups was longer than 1.5 years. The crude hospitalization rate for any reason in the screened group was 199/1000 PY, as compared with 224/1000 PY for the unscreened group ($P < 0.001$). No significant differences were found in hospitalization rates between the screened and unscreened groups for PID (4.6/1000 PY and 5.1/1000 PY, respectively), ectopic pregnancy (2.6/1000 PY and 1.9/1000 PY), infertility (<0.01/1000 PY and <0.01/1000 PY), or for a combination of PID, ectopic pregnancy, and infertility (7.2/1000 PY and 6.8/1000 PY) (Table 2). Some of the women had more than one diagnosis.

TABLE 2. Rates of Subsequent Hospitalizations per 1000 Person-Years (PY)

Reason for Hospitalization	Screened Group Rate (Count)	Unscreened Group Rate (Count)
PID	4.6 (50)	5.1 (175)
Ectopic pregnancy	2.6 (28)	1.9 (70)
Infertility	<0.01 (2)	<0.01 (9)
Combined*	7.2 (78)	6.8 (232)
Any reason	199 (2163)	224 (7598)†

*Combined = PID, ectopic pregnancy, and/or infertility.
†$p < 0.001$.
PID = pelvic inflammatory disease.

TABLE 4. Adjusted Relative Risk of Hospitalization for the Screened Group*†

Reason for Hospitalization	RR	95% CI	*P*
PID	0.94	0.69–1.29	0.72
Ectopic pregnancy	1.39	0.89–2.17	0.15
Combined‡	1.10	0.85–1.43	0.46
Any reason	0.94	0.90–0.99	0.02

*Unscreened group as referent.
†Adjusted for age, race, education, and aptitude score.
‡Combined = PID, ectopic pregnancy, and/or infertility.
RR = relative risk; PID = pelvic inflammatory disease.

The most common reason for hospitalization in both groups was pregnancy and pregnancy-related conditions (Table 3). There were no statistically significant differences in hospitalization rates between the two groups except for "pregnancy and related conditions" ($P < 0.01$) and for "all other reasons" ($P < 0.01$). No specific distinguishing diagnoses within the "All other reasons" category could be identified to explain the observed difference in overall hospitalization rates. The relative risks of hospitalization adjusted for age, race, education, and aptitude score at the time of recruitment into the service are shown in Table 4. The adjusted relative risk of hospitalization for any reason was 0.94 (95% CI, 0.90–0.99) among those tested.

The number of hospitalizations for an individual was 0 to 10 in the screened group and 0 to 15 in the unscreened group. Among those hospitalized, the mean number of hospitalizations for an individual was 1.4 in the screened group and 1.6 in the unscreened group ($P = 0.001$). However, most of the women were hospitalized only once. Of those women hospitalized, 606 (40.4%) of the 1499 women in the screened group and 2267 (46.66%) of the 4859 women in the unscreened group left the service during the study period ($P < 0.0001$).

The screened group consisted of women who were tested and found to have negative or positive test results for chlamydia infection. In the screened group, the subgroup of women with positive test results was significantly different from those with negative test results in terms of age, race, education, and aptitude score (Table 5). Of the 643 individuals who had positive *C trachomatis* test results and underwent treatment, 7 were hospitalized for PID (rate of 7.1/1000 PY). Of the 6410 individuals with negative test results in the original study, 43 were hospitalized for PID (rate of 4.4/1000 PY) ($P = 0.23$). Also in the screened group, one person found to have positive *C trachomatis* test results was hospitalized for ectopic pregnancy (rate of 1/1000 PY), as were 27 of those with negative test results (rate of 2.7/1000 PY) ($P = 0.31$). In the screened group, no one found to have positive *C trachomatis* test results was hospitalized for infertility, whereas two hospitalizations for this condition were recorded among those with negative test results.

TABLE 3. Common Reasons for Hospitalization

Reason for Hospitalization (ICD9 Codes)	Screened Group % of All Hospitalizations* (Rate†)	Unscreened Group % of All Hospitalizations* (Rate†)
Pregnancy and related conditions (630–677)	41.4 (82.3)	42.6 (95.3)‡
Adjustment reaction (309)	9.5 (19.0)	6.4 (14.4)
Injuries (800–959.9)	4.9 (9.7)	5.4 (12.1)
Unspecified viral infection (079.99)	3.7 (7.4)	2.6 (5.8)
Combined sequelae	3.6 (7.2)	3.1 (6.8)
Acute pharyngitis and acute tonsillitis (462–463)	2.9 (5.8)	2.5 (5.7)
Gastroenteritis (558 and 001–009)	2.0 (4.0)	2.0 (4.4)
Noninflammatory disorders of the ovary, fallopian tubes, cervix, vagina, vulva, and menstruation (620–626)	1.9 (3.9)	1.8 (4.1)
Dental disorders (520–525)	1.8 (3.5)	2.3 (5.2)
Pneumonia (484–486)	1.5 (3.0)	1.3 (2.9)
Bronchitis (490–491)	1.4 (2.9)	1.6 (3.6)
Dermatologic conditions (680–709.9)	1.3 (2.5)	1.2 (2.7)
Acute upper respiratory infection (465)	1.0 (2.1)	1.0 (2.2)
All other reasons‡	23.7 (47.1)	26.7 (59.9)‡

*Percentages do not equal 100 because of overlap between "pregnancy and related conditions" and "combined sequelae."
†Rates per 1000 person-years.
‡$P < 0.01$.

TABLE 5. Demographic Data for the Screened Group

	Screened With Positive Results n (%)	Screened With Negative Results n (%)	*P*
Younger than 25 years	595 (93)	5,365 (76)	0.0001
Black race	365 (57)	2,136 (30)	0.0001
Education beyond high school	18 (3)	382 (6)	0.0001
Aptitude score 64 or more	207 (32)	2,573 (40)	0.001

Discussion

This study found that non–healthcare-seeking female Army recruits who were screened, had positive *C trachomatis* test results, and were treated had PID and ectopic pregnancy hospitalization experiences similar to those with negative test results. These two populations were statistically different in terms of age, race, education level, and aptitude. Those with positive screening results are considered to be at a higher risk for contracting multiple chlamydial infections and experiencing the development of sequelae. In the reported screening study of Fort Jackson recruits, the women who participated in the program and demonstrated positive *C trachomatis* test results had significantly greater behavior risk (such as having more than one sex partner in the preceding 90 days or a new sexual partner in the previous 90 days) for infection than those who had negative test results.[9]

How many cases of PID could have been expected in women who had positive *C trachomatis* test results but were not screened and treated? The unscreened group of 21,021 women had a PID rate of 5.1/1000 PY, which was higher than the 4.6/1000 PY observed in the screened group. However, the proportion of women in the unscreened group who were infected with chlamydia on entering the service could not be defined. If 90.9% were not infected when they entered the Army (as found in the screened group) and the PID rate in this theoretical group of uninfected but unscreened women was 4.4/1000 PY (as found in women screened and found to have negative *C trachomatis* test results), 137 cases of PID could be expected in this proportion of unscreened women with theoretically negative chlamydia evidence. In the entire unscreened group, 175 hospitalizations for PID actually were observed.

If it is assumed that the remaining 38 cases involved unscreened women who would have produced positive evidence for chlamydia had they been screened on beginning military service, a 12.2/1000-PY rate of PID would be derived for this cohort. This expected rate of 12.2/1000 PY is 71.8% greater than the rate of 7.1/1000 PY observed in those with positive test results and treatment for *C trachomatis* in the screened group. Despite this higher rate, however, the nearly 2000 women estimated to have positive evidence for *C trachomatis* in the unscreened group may have been too small to detect an elevated PID hospitalization rate in the unscreened group in its entirety, as compared with the women in the screened group.

The samples in the current study were not randomly generated, but self-selected through volunteerism. The lack of adequate behavioral data for the unscreened group did not permit direct comparison of risk for infection between the two groups. Other possible shortcomings of this study include the potential for misclassification of diagnoses and the absence of outpatient morbidity data. Hospitalization discharge diagnoses were defined by the reported ICD9 codes in an Army hospitalization database. Because of resource constraints, hospitalization data were not verified by chart review. Diagnosis and treatment for the sequelae of chlamydial infection, particularly PID, could have been conducted in an outpatient setting. Unfortunately, US Army outpatient data for the period studied had not been validated and were not analyzed.

For the populations screened, data were not collected to define reinfection rates or new infection rates. Outpatient data on chlamydial infections in Army women have not been validated, so they may or may not be based on laboratory testing. However, the rates of PID observed in those screened and treated for *C trachomatis* and those with negative screening evidence suggest that the infections were occurring after the women recruits left Fort Jackson. To develop effective interventions, the reinfection and sex behavior patterns of enlisted Army women must be determined.

Although populations of considerable size were studied, the actual number of hospitalizations for PID was small. However, these hospitalizations were costly because of medical care expenses and because of their impact on the ability of the Army to perform its mission when and where needed.[12,13] Large numbers of female soldiers have critical military jobs and must be prepared for deployment to remote areas whenever called and for remaining at their stations as long as necessary.[13,14] The threat of PID and ectopic pregnancy compromise their reliability as soldiers. Additionally, PID or ectopic pregnancy in a soldier working far from medical care will result in costly medical evacuation. Research on similar *C trachomatis* screening programs should continue the attempt to detect any difference in PID hospitalization rates among screened and unscreened populations.

Information from this study will be useful for designing future studies and economic analyses of STD programs. Future studies must consider both inpatient and outpatient data, with validation of the databases used, as well as assessment of variables related to volunteer participation and behavior that may affect morbidity, hospitalizations, and outpatient visits. A prospective study in which the in- and outpatient experiences of women who complete a behavior risk questionnaire and volunteer for screening are compared with the respective experiences of women willing

to complete the questionnaire but not willing to be screened should be considered. The short- and long-term impact of the education intervention component and the need for screening of male soldiers and its impact also should be evaluated.

In summary, the following groups were examined: (1) women who were not screened; (2) women who were screened; and among those screened, (3) women who had positive *C trachomatis* test results, and (4) women who had negative test results. The respective rates per 1000 PY for PID hospitalization were 5.1, 4.6, 7.1, and 4.4. No statistically significant differences were found in terms of hospitalization for PID or other sequelae associated with *C trachomatis* infection.

This study had several shortcomings associated with an inability to assess reliably the occurrence of *C trachomatis* infections and reinfections in Army women and the sequelae that may follow such infections. It is encouraging to note that the reported screening program may have shown significant effectiveness given more power. The rates of sequelae in the women screened suggest an appreciable rate of infection and reinfection after entry to the Army. The high prevalence of infection among incoming female recruits, the problems in reliably following chlamydial infections and sequelae, and the lack of information about sex practices and the occurrence of new infections and reinfections all present significant challenges.[14]

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