

# The Epidemiology of Varicella Hospitalizations in the U.S. Army

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Varicella infections affect the U.S. Army, but the extent has not been quantified recently. We obtained 1990 to 1997 hospitalization data from the U.S. Army Medical Command and calculated rates using data from the Army Medical Surveillance Activity and the U.S. Army Training Command. There was a decline in the number and incidence of varicella hospitalizations for U.S. Army active duty soldiers from 1990 to 1997. Varicella incidence rates for active duty soldiers are significantly higher for females, blacks, those younger than 20 years, and those whose home of record were tropical island regions. Army initial entry training hospitalizations constitute 11.8% of active duty Army hospitalizations and have also declined. Varicella continues to affect the training and health of the U.S. Army; however, the impact has diminished over the years. A feasible approach to limit varicella in the U.S. Army is to target trainees for screening or vaccination. Refinement of this strategy should be determined from a follow-up cost-effectiveness analysis.

## Introduction

Chickenpox has been reported in the medical literature for more than 300 years, since 1694, when an English physician, Richard Morton, described it.<sup>1</sup> To this day, varicella zoster virus in its primary form as varicella and its reactivation form as herpes zoster continues to cause worldwide morbidity. The Centers for Disease Control and Prevention, citing the National Health Interview Survey, estimates that 3.7 million cases occur annually in the United States.<sup>2</sup> More than 90% of cases occurred in persons younger than 15 years of age.<sup>2</sup> The Centers for Disease Control and Prevention's unpublished epidemiologic and serologic studies and other studies confirm that more than 90% of adults are immune to varicella zoster virus;<sup>2-4</sup> however, the rate of complications is higher for adults.<sup>2,5-9</sup> It is a highly contagious disease that is chiefly spread by respiratory droplets.<sup>2,10</sup> Intermittently, small sporadic outbreaks are reported in the U.S. Army.<sup>11,12</sup>

Consistent with its mission to keep the soldiers healthy and fit to win the nation's wars, the Army Medical Department has instituted a number of vaccinations for recruits at the beginning of initial entry training (IET). The routine vaccinations given to

recruits include adenovirus, influenza, measles, rubella, meningococcus, polio, and tetanus-diphtheria. Conspicuously missing from the list is varicella (or chickenpox) vaccine.

On March 17, 1995, the Food and Drug Administration licensed live attenuated varicella vaccine.<sup>13</sup> On July 12, 1996, the Advisory Committee on Immunization Practices (ACIP) gave its recommendations for use of the vaccine.<sup>2</sup> The ACIP specifically listed military personnel among groups with a high risk for exposure. However, the cost of this vaccine, against a disease with relatively low incidence in this population, required more deliberate epidemiologic analysis.

Toward the end of 1997 and into 1998, the U.S. Army Center for Health Promotion and Preventive Medicine conducted an epidemiologic analysis of varicella disease patterns among U.S. Army active duty soldiers and trainees to support the Army Medical Command and the Office of the Surgeon General in developing a vaccine policy.

Besides the usefulness of this analysis for the U.S. Army for planning purposes and policy setting, the epidemiology of varicella in the U.S. Army serves as an indication of varicella patterns among young adults in the nation.<sup>14</sup> This is particularly useful in that, although varicella is a vaccine-preventable disease, there are few sources for national data on varicella in adults.<sup>14</sup>

## Methods

We obtained records of hospitalizations for active duty Army personnel from the Standard Inpatient Data Record, 1990 through 1997, which records demographic information, length of stay, and up to eight diagnoses coded according to the International Classification of Diseases, Ninth Revision. These data were provided by the Patient Administration Systems and Biostatistics Activities and Analysis Branch of the Corporate Executive Information System at the U.S. Army Medical Command. Admissions were extracted for records with a varicella diagnosis (052.0-052.9) found in any diagnosis field. These data also include inpatient admissions to nonmilitary facilities. Army Reserve and National Guard personnel who were on active duty at the time of admission (e.g., during their time in IET) are also included in the data set.

The U.S. Army Center for Health Promotion and Preventive Medicine's Army Medical Surveillance Activity provided additional data: occupation (medical or nonmedical profession) and active duty Army population numbers by gender, race, age, grade, and home of record distributions (from the military entrance processing stations). The population data were used to calculate varicella rates for those categories of soldiers.

Unfortunately, the databases do not specify which patients are trainees. For the purposes of this study, we defined initial entry trainees as patients who, at the time of hospitalization, self-reported 2 months or less of service; with a rank of private, private first class, corporal, or specialist (grades E1-E4); and

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who were hospitalized at IET sites (Fort Benning, Fort Knox, Fort Leonard Wood, Fort McClellan, Fort Sill, and Fort Jackson). We excluded patients who were hospitalized during the years IET was discontinued at any of these sites.

IET actually includes two categories of personnel: those who go to traditional basic combat training (BCT), and those who attend a combined basic and advanced, specialty-specific training course, called One-Step Unit Training (OSUT). The length of OSUT varies, lasting up to 18 weeks, whereas BCT takes 8 weeks. To calculate IET rates, we obtained data from the U.S. Army Training and Doctrine Command. We estimated the average number of trainees per year by taking the average of the number of incoming and graduating trainees for BCT and OSUT for fiscal years 1993 to 1997. To maintain similar training periods and training environments, we calculated varicella rates for only the first 8 weeks of OSUT, which we combined with BCT rates.

Age and race populations for IET were calculated by standardizing to 1996 age and race distributions of non-prior service active duty, National Guard, and Army Reserve accessions.<sup>15</sup> Observed versus expected varicella hospitalizations were calculated for home of record by standardizing to 1993-1996 home of record population distributions provided by the Army Medical Surveillance Activity. Standardized mortality ratios and 95% confidence intervals were calculated for home of record as described by Kelsey et al.<sup>16</sup>

Data were analyzed with SPSS for Windows 8.0 and Excel 97, and  $\chi^2$  values were calculated using EpiInfo 6.02b.

## Results

Between 1990 and 1997, there were 4,536 hospitalizations in the U.S. active duty Army that included a diagnosis for varicella. Since 1990, there has been a decline in the rate of varicella hospitalization, from a high of 15.9 per 10,000 in 1990 (1,195 cases) to a low of 4.5 and 4.6 per 10,000 in 1996 and 1997 (220 and 222 cases, respectively) (Fig. 1). Table I shows the distribution of cases, rates, and relative risks by gender, race, age, grade, and occupation (medical or nonmedical).

### Active Duty Hospitalizations

Although males constituted more than 85% of all cases, females had a significantly higher risk compared with males (relative risk [RR] = 1.21). Blacks constituted about 40% of all cases and had a significantly higher risk compared with whites (RR = 1.69). Not surprisingly, individuals younger than 20 years and

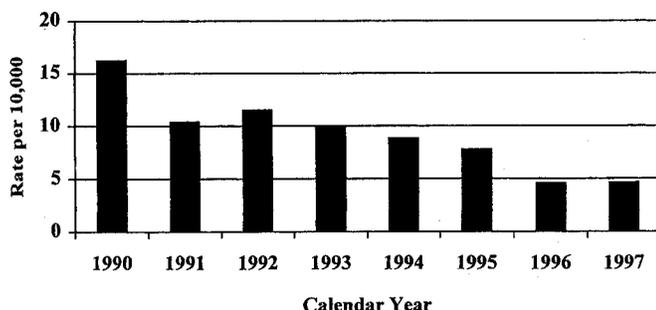


Fig. 1. U.S. Army active duty varicella hospitalization rates for calendar years 1990 to 1997 (n = 4,536).

TABLE I  
TOTAL U.S. ACTIVE DUTY ARMY VARICELLA HOSPITALIZATIONS,  
1990 TO 1997 (N = 4,536)

	Percent	Rate per 10,000	Relative Risk (95% CI) <sup>a</sup>
Gender			
Male	85.2	9.24	-
Female	14.8	11.13	1.21 (1.11-1.31)
Race			
White	52.5	7.90	-
Black	39.2	13.37	1.69 (1.59-1.80) <sup>b</sup>
Other	8.3	8.41	1.06 (0.95-1.19) <sup>b</sup>
Age group			
<20	29.4	38.64	5.36 (5.03-5.71) <sup>c</sup>
20-24	49.5	14.33	-
25-29	14.7	6.14	-
30-34	4.9	2.78	-
35-39	1.1	0.87	-
≥40	0.4	0.49	-
Grade			
Cadet	0.8	- <sup>d</sup>	-
E1-E4	86.6	17.71	5.78 (5.29-6.32) <sup>e</sup>
E5-E9	10.6	2.63	-
O1-O4	31.7	1.56	-
O4-O9	0.1	0.20	-
Occupation			
Medical	11.3	11.25	1.26 (1.15-1.38)
Nonmedical	88.7	8.95	-

<sup>a</sup> 95% confidence interval.

<sup>b</sup> Compared with whites.

<sup>c</sup> <20 vs. ≥20.

<sup>d</sup> Cadet denominator not available.

<sup>e</sup> E1 to E4 vs. all other groups.

lower-ranking enlisted personnel had higher risks compared with all others (RR = 5.36). Those in medical occupations were also at higher risk (RR = 1.26).

Analysis of residence before service revealed that island locations such as Puerto Rico and Hawaii and some states with densely populated areas such as New York and Washington, DC, had significant excess of cases, and many states with rural areas had lower than expected numbers of cases (Table II).

The median length of hospital stay was 6 days, ranging from 1 to more than 90 days.

A large percentage of hospitalizations (40.4%) occur to Army members with less than 1 year of service. Decreasing percentages occur for subsequent years: those with 2 years of service constitute 16.3% of cases, and those with 3 years of service constitute 14.4% of cases.

### IET Hospitalizations

Although there are much higher varicella incidence rates during IET, IET hospitalizations account for only 11.3% of all active duty Army hospitalizations. As in the total active duty Army, the number and rate of varicella hospitalizations during IET declined during fiscal years (FY) 1993 to 1997, although the decline was not as consistent as the decline observed in the total active duty Army (Fig. 2). There were 219 varicella hospitalizations, resulting in an overall rate of 27.8 per 10,000 per year. In FY 1993, there was a high of 78 hospitalizations, with a rate of 45.7 per 10,000. In FY 1996 and FY 1997, there were lows of 25

TABLE II

TOTAL U.S. ACTIVE DUTY ARMY VARICELLA HOSPITALIZATIONS, 1990 TO 1997 (N = 4,536): STANDARDIZED MORTALITY RATIOS BY HOME OF RECORD LOCATION, LOCATIONS WITH HIGHER AND LOWER THAN EXPECTED CASES, AND 95% CONFIDENCE INTERVALS (CI)

	Cases	Rate per 10,000	Ratio (obs/exp) <sup>a</sup>	95% CI
Total = all active duty personnel, 1990 to 1997	4,536	9.47	1.00	-
Top seven locations with higher than expected cases				
Virgin Islands	53	134.76	13.84	(9.86, 17.70)
Philippines	4	65.53	6.73	(1.92, 16.89)
Puerto Rico	250	55.35	5.69	(4.74, 6.31)
District of Columbia	18	22.97	2.36	(1.35, 3.65)
Hawaii	26	18.00	1.85	(1.16, 2.66)
New Jersey	119	15.12	1.55	(1.22, 1.82)
New York	310	13.40	1.38	(1.16, 1.51)
Bottom seven locations with lower than expected cases				
Iowa	18	3.82	0.39	(0.22, 0.61)
New Hampshire	9	4.33	0.45	(0.20, 0.83)
Montana	12	4.58	0.47	(0.24, 0.80)
Maine	15	4.69	0.48	(0.26, 0.77)
Utah	12	4.96	0.51	(0.26, 0.87)
Oklahoma	40	5.22	0.54	(0.36, 0.71)
Minnesota	27	5.33	0.55	(0.35, 0.78)

<sup>a</sup> obs/exp, observed/expected = overall rate for total active duty Army.

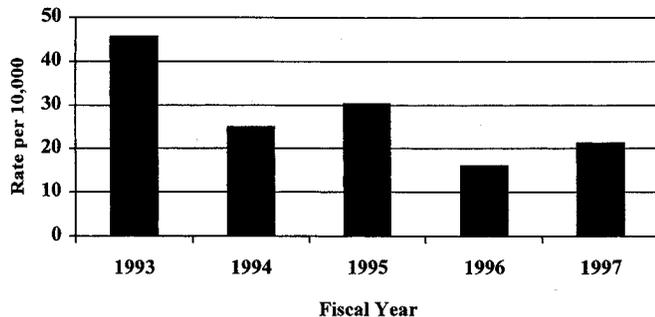


Fig. 2. U.S. Army initial entry trainee varicella hospitalization rates for fiscal years 1993 to 1997 (n = 219).

cases, with a rate of 16.1 per 10,000, and 36 cases, with a rate of 21.2 per 10,000, respectively.

Males made up the bulk of cases during IET, but there was no statistically significant difference in the rate between males and females (Table III). Hospitalizations of blacks accounted for 26.8% of cases, and the risk for blacks was 38% higher compared with that for whites. Almost half of the IET cases (48.0%) occurred among individuals younger than 20 years. However, the rate for older trainees was higher than the rate for younger personnel, which contradicts the finding for the total active duty U.S. Army.

Fort Knox, Kentucky, had a slightly higher rate compared with all other IET posts.

Regarding residence before service, as in the total active duty Army, trainees from Puerto Rico had a higher than expected number of hospitalizations (12 cases). Other locations with a higher than expected number of cases included the Virgin Islands, American Samoa, and New Mexico. However, for these locations there were fewer than six cases per location.

### Discussion

Varicella, otherwise known as chickenpox, is a highly contagious disease spread by respiratory droplets. After an incubation

TABLE III

U.S. ARMY INITIAL ENTRY TRAINING VARICELLA HOSPITALIZATIONS, FISCAL YEARS 1993 TO 1997 (N = 219)

	Percent	Rate per 10,000	Relative Risk (95% CI) <sup>a</sup>
Gender			
Male	82.8	28.3	-
Female	17.2	27.1	0.96 (0.68-1.35)
Race			
White	62.4	26.3	-
Black	28.5	36.5	1.38 (1.03-1.87) <sup>b</sup>
Other	9.1	22.1	0.84 (0.52-1.34) <sup>b</sup>
Age group			
<20	47.5	23.0	0.67 (0.51-0.87) <sup>c</sup>
20-24	43.9	38.0	-
≥25	8.6	24.8	-
IET post location			
Fort Benning	12.2	22.9	0.79 (0.53-1.20) <sup>d</sup>
Fort Knox	14.9	42.0	1.58 (1.09-2.29) <sup>d</sup>
Fort Leonard Wood	26.2	32.8	1.23 (0.91-1.66) <sup>d</sup>
Fort McClellan	7.2	27.18	0.97 (0.58-1.61) <sup>d</sup>
Fort Sill	8.6	20.46	0.70 (0.44-1.13) <sup>d</sup>
Fort Jackson	30.8	25.92	0.89 (0.67-1.18) <sup>d</sup>

<sup>a</sup> 95% confidence interval.

<sup>b</sup> Compared with whites.

<sup>c</sup> <20 vs. ≥20.

<sup>d</sup> Individual post compared with all others.

period of about 2 weeks, rashes with small pustules form. The pustules eventually break open, dry, crust, and flake off. The disease is contagious 1 to 2 days before the onset of rash, and it lasts until the lesions are crusted. It is considered a "childhood disease" and usually lasts 4 to 5 days. For adults, the disease is usually more severe with an increased risk for complications, including bacterial infections of skin lesions, pneumonia, dehydration, encephalitis, and hepatitis.<sup>2,5-9</sup>

After the course of disease, the virus remains dormant in the sensory nerve ganglia and can reactivate as herpes zoster or

shingles. Herpes zoster is more common in the elderly and immunocompromised individual. Although rare, zoster can also occur in younger adults and children. About 15% of the population develop herpes zoster during their lifetime.<sup>2,10,17</sup> We did not analyze the epidemiology of zoster.

We describe the epidemiology of varicella infections for two populations: the total U.S. Army active duty population and a subset of the active duty population, the initial entry trainees.

As suspected, the rate of hospitalization per year for varicella is much higher during IET compared with the total active duty force, because initial entry trainees are younger than the rest of the active duty Army and unique cohorting conditions exist during IET. During IET, recruits from different regions of the country and from outside of the country are placed together in relatively close living arrangements. This mixing of people, especially those who are not immune, vastly increases the transmission of an infectious disease.<sup>18</sup>

Based on previous studies, the susceptibility rate for varicella among recruits is around 6 to 9%.<sup>3,4</sup> However, with the current ACIP recommendations for use of the vaccine, the epidemiology is likely to change in the foreseeable future.<sup>2,5,19</sup> As of mid-1997, vaccine coverage was 25% for individuals aged 19 to 35 years nationwide.<sup>20</sup> If vaccination coverage increases, we expect the susceptibility in the U.S. Army to decline when cohorts of adequately vaccinated groups reach the age of admission into the Army. On the other hand, we may also see varying rates for adults with fluctuating vaccine coverage for children. An initial decrease in natural disease transmission may result in a cohort of susceptible adults and leave the potential for outbreaks during the early years of national vaccination.<sup>21</sup>

For our study, incidence rates in both the total Army and in IET declined in the past few years. Because the vaccine was only licensed in March 1995 and is used primarily on pre-adolescent children, our rates are probably not greatly influenced by the introduction of the vaccine.

Although ideally we would have liked to determine the incidence of disease through outpatient and inpatient data, the data were neither available for outpatient visits nor as reliable for earlier years of hospitalization. In the Army, a varicella patient is more likely to be hospitalized, not because of increased severity but to isolate the patient from other susceptible members.<sup>14</sup> This is particularly true for soldiers living in a dormitory-type situation, such as during formal training periods. Therefore, hospitalization is a reasonable approximation of cases.<sup>22</sup>

Rates of varicella in military populations have also been described in other papers.<sup>14,23-25</sup> For both the Army and the Navy, between 1980 and 1990 there was an increase in cases;<sup>14</sup> this was followed by a steady decrease in cases until 1994 for the Navy.<sup>24</sup> For the Army, the decline continued from 1990 to 1997 (our latest available data). There was also a general decline in the number and incidence rate of varicella hospitalizations during IET between FY 1993 and FY 1997.

One possible reason for the observed decline in varicella hospitalizations for the total U.S. Army active duty population could be a possible overall change in hospital administration policy. The Medical Surveillance Monthly Report published by the U.S. Army Center for Health Promotion reported a decline in all hospitalizations for the total U.S. Army active duty population between 1990 and 1997.<sup>26</sup> Some epidemiologists have attrib-

uted this to the effects of managed care initiatives on hospitalization.<sup>26</sup> Our observed decreasing trend in varicella could be attributable to a policy shift away from hospitalizations to case management by outpatient visits or home care. However, the decline in rates for IET posts cannot be explained by a change in policy. The varicella policy for IET has remained consistent during the past few years for all IET posts: all trainees from 1990 to 1997 with varicella were formally admitted to the hospital (Mr. Lutz Aguirre, Fort Benning; MAJ William Hewitson, Fort Leonard Wood; MAJ Mark Kortepeter, Fort Sill; MAJ Francine Ledoux, Fort McClellan; LTC Jane Lindner, Fort Jackson; and LTC David Niebuhr, Fort Knox, personal communications, December 1998).

Another explanation for the increase in rates during the 1980s followed by a decrease in rates in the 1990s could be the cyclical nature of some diseases. Gray et al. refer to data from Massachusetts demonstrating an increase and decrease of varicella cases in 50-year intervals.<sup>14</sup> We may also be seeing a cyclical pattern with a different periodicity in the Army. Regardless of the cycle, increased vaccine use should affect varicella rates.

Females were at a significantly increased risk compared with the total active duty population, although this effect was not reflected in the IET population. Other studies of military populations have demonstrated differences in rates between the sexes; however, the results have been conflicting. Two studies by the Navy found slightly higher rates among men,<sup>14,24</sup> whereas an analysis of previous Army data from 1980 to 1986 found no gender difference.<sup>14</sup> Seroprevalence studies of military recruits have also yielded varying results.<sup>3</sup>

Varicella, considered a childhood disease, is clearly associated with age.<sup>2,10</sup> More than 90% of cases occur in persons younger than 15 years of age.<sup>2</sup> Higher rates in younger service members have been described previously.<sup>3,14,24</sup> We see the same pattern of higher rates in younger soldiers in the total active duty Army and observe that there may be an increased risk of exposure. Younger and lower-ranking soldiers are more likely to be exposed to crowded working and living situations and thus have increased exposure to persons who may have the disease. This occurs during IET and other training situations, when soldiers are living in dormitories or barracks housing. In our analysis of IET, we did not find younger soldiers to have higher rates; perhaps there are other confounding variables unavailable in our data.

We found blacks to be at higher risk compared with whites for both the active duty force and trainees, which is consistent with other studies that have also demonstrated higher rates of adult varicella or higher seronegativity for blacks.<sup>3,4,14,24</sup> Although we were unable to determine rates for Hispanics, other studies have observed that Hispanics have higher adult varicella rates compared with whites.<sup>14,24</sup>

Our study confirms previous findings in the literature of differences in risks attributable to geographic location.<sup>10,11,14,24-27</sup> We found that active duty soldiers and trainees from tropical or island locations such as Puerto Rico had higher rates compared with what was expected. Reasons for this have been hypothesized, such as less exposure to disease or environmental factors such as heat and humidity, which could possibly play a factor in virus transmission.<sup>11,14,24,27,28</sup> Our analysis by home of record also reveals that soldiers from some states with densely popu-

lated cites such as New York and Washington, DC, have higher than expected rates; states with large rural areas such as Montana and Iowa have lower rates. However, we could not analyze the data specifically by urban or rural home of record and recommend additional investigation of this finding. Fort Knox, Kentucky, had higher rates compared with all other IET posts.

Active duty personnel involved in a health care occupation have a higher rate compared with those in non-health care occupations. Those in health care are more likely to be exposed to a clinical setting in which varicella patients, adult and pediatric, may be present. Several studies have concluded that immunizing health care workers is cost-effective,<sup>14,29,30-32</sup> and the ACIP recommends that health care workers be immune to varicella.<sup>33</sup>

Although rates have declined, varicella still negatively affects the U.S. Army and the military.<sup>11,12,23</sup> There may be several strategies for implementation of the vaccine if the U.S. Army chooses to use it. However, the feasibility of implementation and cost-effectiveness should be addressed.

Targeting higher-risk groups based on sex, race, age, or home of record is problematic. Although blacks and those from tropical locations have higher rates, a policy based on race or home of record may be seen as discriminatory.

IET would seem a likely time to immunize soldiers because rates are high and it would be best to intervene early in a soldier's tenure in the Army. Should the vaccine be administered to all soldiers or only to screened seronegative soldiers? There are logistical, financial, and scheduling issues associated with screening during a short 8-week training schedule. Several studies have compared self-reported history of varicella with serostatus, and the results have been equivocal<sup>34-36</sup> (Dr. Margaret Ryan, personal communication, December 1998).

Given the changing trend in varicella rates, the costs of hospitalization and outpatient care, the issues associated with screening/vaccination strategies, and decreasing public health budgets, we recommend a follow-up cost-effectiveness analysis of possible vaccine intervention strategies.

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