

# Mumps in the US Army 1980–86: Should Recruits Be Immunized?

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**Abstract:** The US Army's experience with mumps hospitalizations was examined for the years 1980 through 1986. One hundred fifty-two cases among active duty Army soldiers were identified. Mumps rates declined from 3.85 per 100,000 active duty soldiers per year in 1980 to 1.28 in 1985, but an outbreak during 1986 caused rates to jump to 6.65. Attack rates were found to decline dramatically with increasing age or length of military service, with 74 per cent of cases occurring in soldiers with three years or less of service. Rates for Blacks and Whites were similar, but were higher for other minorities. Complications reported were mild. A cost-benefit analysis, assuming

all recruits were to be vaccinated, estimated average annual vaccination program costs of \$286,789; this figure exceeds average annual reported hospitalized mumps disease costs of \$61,525 by a factor of 4.7. Mumps attack rates would have to reach at least 15.0 per 100,000 per year before savings would equal recruit vaccination costs. Failure to show that a vaccine program would be cost-saving may be due to limitations in identifying cases or to the requirement that all recruits be immunized regardless of prior immune status. It is likely that a program to immunize susceptible individuals alone would show benefit. (*Am J Public Health* 1989; 79:471–474.)

## Introduction

Mumps has been perceived as an acute communicable disease of childhood for at least 20 years, but in earlier times it was viewed primarily as an illness that affected armies during mobilizations. Mumps was one of the most important causes of days lost from active duty by the US Army in France during World War I, with an average annual hospitalization rate of 55.8 per 1,000 average strength.<sup>1</sup> In World War II and afterward, however, the US military experienced much lower mumps rates and only isolated epidemics. This decrease between the world wars was attributed to increasing urbanization with resulting increased transmission during childhood.<sup>2</sup>

The introduction of mumps vaccine in December 1967 resulted in a dramatic decline in reported mumps attack rates among the US population. Centers for Disease Control (CDC) figures show a 98 per cent drop from 1968 levels, to an all-time low of 1.2 cases per 100,000 population in 1985.<sup>3</sup> In 1986 and 1987, however, there were reports of mumps outbreaks in secondary schools and colleges.<sup>4,5</sup> US rates rose to 3.2 per 100,000 in 1986, with 7,790 cases reported, while the provisional total for 1987 is even greater at 12,200 cases.<sup>5</sup> These increases have resulted in calls for vaccination programs directed at young adults who have not been immunized previously.<sup>4,6</sup>

The US Army, whose soldiers are largely in their early 20s, experienced a similar mumps outbreak in a unit stationed in the Republic of Korea during the spring of 1986. This outbreak consisted of 29 known symptomatic cases over a four-month period, with a crude attack rate of roughly 4 per 1,000 soldiers. (CPT Robert Pero, MD, unpublished data.) In response to this outbreak and the perception that a new immunization program for recruits might be indicated, this study was undertaken to examine the recent history of mumps in the US Army, and to consider whether an immunization program would be justified on cost grounds.

## Methods

The US Army Medical Department maintains a worldwide, computerized Individual Patient Data System (IPDS)

hospital admission data base for administrative purposes. Each IPDS hospital discharge record contains basic demographic, geographic, length-of-stay, and disposition information, including convalescent time, as well as up to eight diagnoses and eight procedures. These are coded according to the International Classification of Diseases, 9th Revision (ICD-9).

All discharge records with a mumps-related ICD-9 code for the years 1980–86 were retrieved. This period was chosen because it was felt that policy should be based on the Army's most recent experience with mumps illness for which accurate data are available. Because the question of interest is mumps disease impact on active duty soldiers, the 215 total cases identified were limited to a subset of 152 active duty Army, excluding dependents, retirees, and other service members. Denominator data were obtained from the Defense Almanac, published annually by the Department of Defense.

While mumps in the civilian population may be under-reported by as much as a factor of 10,<sup>7</sup> military symptomatic cases have a much higher reported hospitalization rate, especially among lower ranking soldiers who live in barracks. These individuals are admitted to respiratory disease wards largely as a transmission control measure, e.g., virtually every overtly symptomatic case in the Korean outbreak was hospitalized. Hospitalized cases were therefore used as a proxy for all cases, with the understanding that some underestimation remains.

Outpatient costs associated with mumps hospitalization were calculated assuming two clinic visits per case (admitting and follow-up) plus one additional follow-up visit for each complication reported during hospitalization. Clinic and daily hospitalization costs for the most recent (1986) fiscal year were obtained from the Army Health Services Command (HSC) which calculates average costs across all Army hospitals within the 50 states. These costs are \$322.82 and \$67.83, respectively, and include all associated plant, salary, supply, and inpatient medication expenses. Overseas costs in US Army facilities are similar, due to use of similar staffing and military supplies.

As the analysis used is based on a steady state model in the present, the 1986 costs were applied to all cases, ignoring inflation during the period. Intangible costs for pain and suffering were excluded. Average annual costs were computed using the mean annual number of hospital days and convalescent days (to estimate total lost pay costs) for the entire seven years of data, and these average costs were

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compared with average annual estimated vaccine program costs.

The Army currently administers measles and rubella vaccine (MR) to all enlisted recruits. Therefore the cost to initiate a mumps vaccination program would be little more than the Army's additional cost per dose for measles, mumps and rubella vaccine (MMR) over MR. In mid-1987, this cost was \$1.542, based on the standard 10-dose vials. The estimation of mumps vaccine administration costs was derived by applying this incremental cost to the 180,000 average annual number of enlisted accessions to basic training (MAJ John Brundage, MD, MPH, personal communication), a number which includes Army Reserve and National Guard enlistees.

An 85 per cent overall vaccine effectiveness rate was assumed in calculating disease costs that would accrue in spite of a vaccination program. Recent estimates of clinical mumps vaccine efficacy range from 75-91 per cent.<sup>5,8,9</sup> Officer accessions, however, as well as all current active duty would not be included in the proposed program, so overall effectiveness in this population would tend to be less than the maximal efficacy. (In the earliest years of such a program, effectiveness might be lower still, since only new accessions would be covered.)

**Results**

Table 1 summarizes the active duty experience of mumps hospitalizations over the seven-year period. While grouped age-specific rates are included for comparison, the Army's age distribution is very skewed to younger ages in the groupings above age 20, causing some of the apparent elevation of these rates. The direct age-adjusted Army rates are below reported US rates for the same period. Prior to 1986, rates had been trending downward for both the Army and the US, but the Korean mumps outbreak caused the Army rates to increase five-fold that year as compared to 1985. Through December of 1987, the Army recorded 33 active duty cases, making the provisional 1987 rate 4.2 per 100,000. This is a decline from 1986 rates, yet is still twice the 1980-85 average of 2.14.

**TABLE 1—Annual Incidence of Mumps Hospitalizations per 100,000 Active Duty US Army Soldiers for the Years 1980-86 Compared with Overall US Mumps Rates as Reported by the CDC\***

Incidence	1980	1981	1982	1983	1984	1985	1986
Army cases	30	16	10	18	16	10	52
Army rate	3.85	2.05	1.28	2.31	2.05	1.28	6.65
Age-adjusted Army rate†	2.2	0.9	0.5	0.9	1.0	0.4	2.7
Army rates by age group							
16-20	7.5	3.2	3.1	4.3	3.1	2.6	14.1
21-25	2.2	2.2	1.1	2.3	2.7	1.9	7.3
26-30	3.8	0.8	0.7	2.0	0.7	0.6	3.8
31+	2.8	1.7	0.5	1.0	1.6	0.0	2.5
US rate	3.9	2.2	2.5	1.6	1.3	1.2	3.2
US rates by age group							
15-19	2.6	2.0	3.8	1.8	2.0	2.4	9.0
20-24	0.6	0.6	0.6	0.4	0.4	0.5	0.9
25-29	0.5	0.5	0.5	0.3	0.3	0.4	0.4
30+	0.2	0.1	0.1	0.2	0.2	0.1	0.2

\*US rates for 1980-83 derived from MMWR's Annual Summary, 1980 through 1983, published by CDC; other US rates from reference 5. DOD and CDC use different age groupings in compiling their published data.

†Direct adjustment to resident US population distribution per Statistical Abstract of the United States, published annually by US Bureau of the Census.

Age, race, sex, and length of service-specific rates for the entire period are presented in Table 2. There is a clearly decreasing trend in attack rates with respect to age and length of service. While rates for Blacks and Whites appear similar, those for other minorities are significantly higher. In 1985, the Army began classifying Hispanics as a distinct race/ethnic category in IPDS data. Race/ethnic rates were recalculated for 1986 alone, with the Hispanic rate, based on five cases, being more than twice that of Whites. No overall difference with respect to sex was found.

Clearly, the sharp decline in rates with increasing length of service is confounded by the fact that those with longer service records are usually older. However, mumps is not occurring primarily in basic training camps. Only 15 (9.9 per cent) of the cases occurred in soldiers within their first 90 days of service.

It was considered that because of much higher rates 1986 might have been different from the 1980-85 period, so the analysis was repeated for these years separately. Except for the higher rates, the mumps disease patterns in 1986 were consistent with the prior years, and it is therefore appropriate to use all seven years of data for the overall cost-benefit calculations.

Complication rates are important in estimating permanent sequelae and total disease costs. Unfortunately, the ICD-9 does not list all possible mumps complications in its coding system (e.g., mastitis, reported in 15 per cent of females<sup>10</sup>) so it cannot be determined if these occurred. Seventy-nine per cent of the cases had no reported complications. Among mumps-related complications, orchitis was seen most frequently (26 cases, 19 per cent of males), followed by meningitis (two cases) and encephalitis, nephritis, and testicular atrophy (one each). These complications were apparently mild, and all 152 patients returned to active duty without disability.

The median number of sick days (inpatient plus conva-

**TABLE 2—Summarized US Army Age-, Race-, Sex-, and Length of Service-Specific Hospitalized Mumps Cases and Rates per 100,000 Active Duty for 1980-86**

	Cases	Rate
Overall total	152	2.78
Age group* (years)		
16-20	63	5.54
21-25	52	2.81
26-30	19	1.77
31-35	9	1.34
36-40	6	1.38
41-45	2	1.14
46-50	1	1.72
51	0	0.00
Race		
Black	35	2.29
White	95	2.66
Other†	22	5.56
Sex		
Male	139	2.84
Female	13	2.16
Length of Service (years)*		
<1	57	7.05
1-3	56	2.99
4-6	17	2.19
7-9	7	1.19
10+	15	1.16

\*p < 0.0001 by  $\chi^2$  test for trend.

†Includes Hispanic cases, which were not reported separately prior to 1985. Hispanic rate for 1986 alone = 18.3 per 100,000.

lescent time) was seven, and the mean 9.6. Inpatient care amounted to 73 per cent of total sick time, with the remainder spent on convalescent leave. The range in total sick time was 1 to 267 days, with 95 per cent of the patients having 19 or fewer days. The most extreme outlier suffered complications due to gastric surgery. Another outlier at 49 days suffered complications of labor and delivery. Since it was not known whether these complications were not in some way related to the individuals' mumps illnesses, they were retained in the cost calculations with the understanding that any resulting bias would tend to favor a decision to immunize.

Estimated annual disease costs were calculated based on the mean attack rate for the 1980–86 period. There were a total of 1,057 inpatient hospital days recorded, an average of 151 per year. Multiplying by the specified daily hospital cost yields an average annual hospitalization cost of \$48,764. The estimated total number of associated clinic visits was 207, or 30 per year. Multiplying by the specified clinic visit cost yields an average annual clinic cost of \$2,006. Lost pay costs based on total reported sick days and pay scales in effect on January 1, 1987 were \$75,412, an annual average of \$10,773. The sum of these three average annual costs is the total estimated disease cost for an average year at 1986 cost levels, \$61,525.

Estimated vaccine program costs (annual number of enlisted accessions multiplied by the \$1.542) yielded a figure of \$277,560. Applying the estimated 85 per cent vaccine effectiveness rate to the average number of reported cases left an expected three nonpreventable cases. Costs for these cases were calculated proportionally to be \$9,229. Thus, the total estimated annual expenses under a vaccination program would be \$286,789. This exceeds the direct and indirect costs for hospitalized cases by a factor of 4.7.

Table 3 compares disease costs with vaccination program costs at various attack rates assuming a steady state. The costs for 1986 were calculated from that year's data alone by the same procedure as the overall comparison described above. It is worth noting, however, that the extrapolated estimate of total 1986 disease costs, using the overall average cost per case, would be within \$2,500 (1.6 per cent) of the actual cost. This agreement tends to support the extrapolation to the break-even number of cases and corresponding attack rate, which were solved for algebraically under the assumption that all disease costs would rise proportionately

**TABLE 3—Comparison of Hospitalized Disease vs Vaccination Program Costs at Various Mumps Attack Rates**

	Average 1980–86	1986	Break-even*
Attack rate (per 10 <sup>5</sup> per year)	2.78	6.65	15.0
Number of cases	22	52	117
Mumps disease cost			
Medical costs	\$50,752	\$126,240	\$269,350
Nonmedical costs	10,773	16,977	57,200
Total	\$61,525	\$143,117	\$326,550
Vaccination program costs			
Vaccine cost	\$277,560	\$277,560	\$277,560
Non-preventable case costs	9,229	21,468	48,990
Total	\$286,789	\$299,028	\$326,550
Vaccine:mumps cost ratio	4.7	2.1	1.0

\*Projected costs and rate at break-even point are rounded estimates.

with increasing rates.\* Reported mumps attack rates would have to exceed at least 15.0 per 100,000 annually before the cost ratio would favor vaccination.

### Discussion

The use of hospitalization records to estimate rates and compute costs is not without pitfalls, but some of these may be minimized by the unique aspects of the military population under study. Because of the much higher hospitalization rates for mumps in the military, these rates are felt to be an adequate proxy for reported rates. However, there are still limitations in identifying cases. Asymptomatic cases are almost never reported in either the civilian or the military sector, but from a cost-benefit standpoint, asymptomatic cases do not contribute any costs, and their exclusion is less important. Mild cases, which are unhospitalized and undocumented, would incur medical and nonmedical costs, but at a lower rate.

The racial differences noted may be of some interest, especially the apparently high non-Black minority rate. Previous studies have tended to show that race has no effect, although Blacks may have higher rates at an earlier age.<sup>11</sup> Our data are insufficient to determine if these higher rates are limited to Hispanics alone. A similar data analysis showed that in 1985 Hispanics in the Army had roughly six times the rate of varicella illness, relative to Whites (MAJ Patrick Kelley, MD, MPH, unpublished data). Many of these cases came from Puerto Rico where varicella transmission is low. It is speculated that either a similar difference in prior exposure or a difference in prior immunization is occurring with Hispanic mumps cases.

As any mumps-related diagnosis caused inclusion in the data set, it was impossible to determine if a complicated case acquired the infection before or after admission, and thus whether the reported complications were directly related to the mumps infection. The decision to include the outlying cases in the cost calculations increased the estimated disease costs by roughly 20 per cent. On the other hand, the fact that the IPDS data did not differentiate intensive care unit (ICU) bed days from regular bed days might lead costs to be underestimated (the Army's medical ICU bed cost is nearly three times higher than regular bed cost), although medical ICU usage in mumps illness is probably limited to the rare severe meningitis or encephalitis case.

Including Army Reserve and National Guard trainees in the proposed immunization program increases program costs, while most disease prevention savings would occur outside the military health care system where it is not captured in the calculations. These recruits train side-by-side with active duty soldiers and are required to receive the same vaccinations, but return to civilian life within 120 to 180 days. About one-third of the basic trainees are reservists or guardsmen during a given year. Assuming their disease rates are the same as the active duty population, the total mumps disease cost might be one-third higher. This is still not enough for the program to be cost-beneficial.

The conclusion that the proposed vaccination program might not save money was not expected. There is no doubt

\*The equation solved is (cost per case)  $x$  = (vaccine cost) + (proportional cost for non-preventable cases), where  $x$  is the number of mumps cases at which vaccination program costs equal disease costs, and the proportional cost for non-preventable cases is 0.15 (cost per case)  $x$ . This is a linear extrapolation based on the average cost per case.

that vaccination programs are cost beneficial when applied to completely unvaccinated populations.<sup>12,13</sup> What is certainly the case here, however, is that a large proportion of the military recruit population is already immune, due to prior vaccination or illness. Surveys of US military recruits taken in the 1950s and 1960s, when post induction mumps rates were higher, found antibodies to be present in 54–76 per cent.<sup>14,15</sup> Cochi, *et al*, using data from the United States Immunization Survey, estimate vaccine coverage in 15–19 year-olds at 55 per cent and rising, as of 1985.<sup>5</sup> This immunity has two major impacts on the results. First, it prevents attack rates from approaching those seen in pediatric or otherwise virgin populations, on which most previous cost-benefit analyses were based. Second, it means that a large amount of the vaccine given in a blanket immunization program would be wasted, raising vaccination costs unnecessarily.

The Army does not generally use previous civilian immunization records to exempt basic trainees from the usual schedule of vaccines, so the obvious solution of simply vaccinating those without proof of prior immunization could not be immediately implemented. Relatively few recruits now arrive at basic training camps with valid immunization records in hand, and the administrative costs of determining each individual's immune status may exceed the \$1.54 vaccine cost. As preinduction immunization rates for mumps and other diseases rise, however, a policy of selectively immunizing recruits based on review of records would likely become cost-beneficial.

Excluding intangible costs for pain and suffering, as well as neglecting later life costs of sequelae, may be questioned in this study because of the failure to show any strict monetary benefit from a vaccine program. In fact, if the cost ratio had been closer to 1.0 we would have argued in favor of a vaccination program on the basis of such benefits. But the actual complications seen here and those generally reported<sup>4,10</sup> are usually self-limited, and serious sequelae are generally considered rare,<sup>12,13,16</sup> so it is less likely that this analysis has overlooked a large potential cost that would invalidate the conclusions. Reports of sterility, perhaps the most feared sequela in postpubertal males, are very sparse,<sup>16</sup> and it is therefore discounted.

The usual explanation for the recent rise in mumps incidence among secondary school and college age populations is that there is a nonimmune cohort in the population that missed both mumps immunization and illness in the 1970s, when rates were falling and before states passed school vaccination laws which included mumps.<sup>5,6</sup> If this is the case, the frequency of mumps outbreaks should decrease after a few years, as this cohort passes into adulthood. In the interim, monitoring of Army mumps rates for any increase is

indicated, and the 16 states that currently do not require mumps immunization for grade school enrollment<sup>17</sup> should be encouraged to enact such laws. While this study's perspective is necessarily narrow, in that only current disease costs are considered, it appears that Army mumps rates would have to more than double from 1986 levels before a blanket immunization program would be cost-beneficial. A current serological survey of the recruit population is planned to better address potential changes in requirements for mumps and other vaccines.

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