Surveillance and Control of Tuberculosis in the US Army: Old and New Issues

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Abstract

Objective: The re-emergence of tuberculosis in the military has occurred in light of the change in the epidemiology of tuberculosis in the United States as well as the changes in the missions of the post-cold war military. Peace-keeping and humanitarian missions entail insertion of the military in regions where public health infrastructure has deteriorated as well as increasing interactions between military members and the indigent populations. Downsizing in the military has also resulted in the increasing use of local human resources. The USACHPPPM, in its mission to recommend best practices for disease and injury control, analyzed the military's historical experiences with TB during WWII, Korea, and Vietnam and compared them with current surveillance and control.

Methods: We reviewed the literature of tuberculosis in the US military, especially outbreaks of active disease, and studies of tuberculosis acquired during military deployments, including the seagoing Navy, and Permanent Changes of Station (PCS). We also reviewed current data to obtain a crude incidence rate of active TB disease in the U.S. Army. Calculated rates of active TB endemic to potential regions of deployment were also reviewed.

Results: During WWII, the annual incidence of active TB in the U.S. Army ranged from 100-175/100,000 soldiers. Average annual case rates dropped in general from the 1950's through the 1970's, even with increased exposures during the Vietnam Conflict. The annual incidence rate in the Army since 1990 ranges from 3.27-4.55/100,000 soldiers. Persons in the Pacific Rim have the highest risk of disease.

Conclusions: Surveillance and control of tuberculosis is a multi-factorial problem. In the military, exposure to tuberculosis can occur as a result of outbreaks, interactions with local workers and residents during military operations, and interpersonal relationships, both short and long-term. We conclude that the history of TB in the military is characterized by multiple outbreaks, individual infections acquired while deployed to or stationed in regions of high endemic rates, soldiers entering the service with previous TB infection, and military dependants emigrating from high-prevalence regions.

Background

Tuberculosis (TB) remains as one of the most important infectious disease in the world. Recent estimates indicate that approximately 90 million new cases of tuberculosis will occur this decade alone [1]. Tuberculosis has been recognized as a serious problem in the Military as early as 1854, with over 13,000 TB hospitalizations and 5,000 TB deaths during the Civil War[2]. During World War I (WWI), TB was the Army's leading cause of discharge for disability. The Armed Forces Epidemiological Board (AFEB), a board of scientists and physicians that make preventive medicine and public health recommendations to the Department of Defense (DoD), recognized the difficulties of TB surveillance as early as 1964 and made recommendations to study Tuberculin Skin Test (TST) surveillance.

The end of the cold war brought changes in the traditional missions of the U.S. military. New missions such as peacekeeping and refugee protection, the increased tempo of deployments from downsizing, and the increasing reliance on local human resources to meet support needs have resulted in increasing interactions between military members and indigent populations. This has made TB as relevant today as it was during WWI and earlier.

Initial reports on soldiers returning from Operation Joint Endeavor (OJE) in the Former Republic of Yugoslavia (FRY) were concerning to the Army's Preventive Medicine community. Preliminary data indicated that there was an increased rate of tuberculosis converters; that PPD tests were improperly administered or read; and that different brand preparations of the PPD test offered different sensitivities and specificities, with important implications regarding surveillance, prevention, and control of active disease.

The USACHPPM, in its mission to recommend best practices for disease and injury control, analyzed the US military's historical experiences with TB during WWII, Korea, and Vietnam and compared them with current surveillance and control.

Methods

A review of the US Army's TB policy and experience was done. This policy review used previous and current Army Regulations (AR's) as well as presentations and proceedings at the Armed Forces Epidemiological Board. We conducted a review of published literature using general MEDLINE and the Index Medicus and of unpublished studies and documents obtained from individuals with clinical, research, or policy work relevant to TB in the Army. We utilized the US Army's centralized inpatient database, DMSS to obtain the active tuberculosis incidence rate for active duty soldiers from 1990 to 1997. Using World Health Information, we compared geographic areas with different endemic rates for active tuberculosis versus areas of potential US Army deployments.

Results

Army Regulation and Guidelines

Guidelines for TB surveillance in soldiers are outlined in Army Regulation (AR) 40-5 (fig 1). Guidelines for post-deployment tuberculosis screening from Operation Joint Endeavor specified that a PPD test was to be administered to soldiers within 90 days from theater departure. Regulations for the Navy, in BUMED/NAVMEDCOM regulations chapter 6224.1, and the Air Force, in AF instruction 48-115 are currently for yearly testing of all personnel other than health care staff, regardless of duty and risk of disease[3].

Literature Review

(See fig 2, 3)

Soldiers deployed overseas during WWII were found to have rates of 100-175/100,000/year of active disease, based on CXR studies[4]. Most new infections were acquired from fellow soldiers, not civilians, and much disease was due to infection acquired before enlisting in the Army.[5] Studies on WWI and the Korean War also found that soldiers who were prisoners of war (POW) had significantly increased rates of active disease and excess mortality due to TB compared to all soldiers and all POWs.[6]

Studies in Vietnam showed that spending more time in theater was associated with increased rates of TST conversion[7,8].

Studies of the Army, Navy, and Air Force all showed deployment, Permanent Change of Station, or sailing into ports in the Pacific or East Asia were associated with increased infection by TST and active disease[9,10,11].

Several studies showed that up to 50% of active TB, and high rates of TST reaction, occurs in personnel who were infected on entry into service[12,13,14], especially those whose geographic origin was a known highly endemic area[15]. Although quantitative data was unavailable, many individuals had a history of BCG vaccination,.

One study identified a significant burden of TB disease in dependents of personnel living in highly endemic regions[16].

There were no peer-reviewed studies on TB in Operation Desert Shield/Desert Storm (ODS), the 1991 conflict in the Persian Gulf between an American-led-coalition and Iraq. There were no published studies on Operation Restore Hope (Somalia, 1993), Restore Democracy (Haiti, 1995), or Joint Endeavor/Joint Guard (The FRY, 1994). There has been only one Surgeon General Report on TB in Somalia, and one study, submitted for publication, on the FRY.

Rate Analysis

Analysis of the DMSS shows that since 1990 there have been a total of 157 cases of active disease in active-duty personnel. Using yearly estimates of end-strength of the Army, annual rates of disease ranged from 3.27-4.11 cases/100,000 (fig 4). No data is available on PPD conversion rates for the Army.

Military ability to perform surveillance and control

Many of the studies of TB in the US military noted difficulties in the implementation of PPD surveillance and medical response to converters. Up to 50% of PPD+ individuals were identified either at induction into or discharge from the service[17], rather than proximate to the time of an exposure and infection. In 17-50% of records, no previous record showed TST surveillance having been performed, despite Army regulation or guideline[18,19]. Improper recording of TST was noted, recording as “positive” or “negative” without a millimeter size of induration[20]. 16% of TSTs in one study that were placed were never read[21]. Some studies found that records were in clear error, negative test results recorded in the charts of personnel whose tests were known to have been positive[22]. Studies found that 45-60% of those found to be TST positive, often in the context of contact with a case of active disease, were put on chemoprophylaxis according to proper ATS/CDC and military guidelines[23].

These studies are in keeping with recent DoD reports from deployments. An OTSG report on TB surveillance in Somalia noted that pre-deployment surveillance was not done adequately to establish a negative baseline, and that up to one-third of reported PPD tests done in theater were confirmed on return to the US, as per Army standard[24]. The 12,045 personnel who did complete proper screening on return from the FRY consisted of only 50% of those who should have received testing. Of them, 50% of new positive reactors had improperly documented records, and could not be confirmed as having newly converted while deployed and therefore requiring INH prophylaxis. There are multiple anecdotes from Army Community Health Nurses, Preventive Medicine Officers, and Medical Corps Members of individuals lacking requisite training and skills for correctly reading a PPD skin test.

The practice of inconsistent use of different PPDs and methods of administration was described. The same study on personnel leaving the FRY found that both the Parke-Davis and Connaught brands of PPD were being used simultaneously, and that each gave differing results on the same individuals[25]. In

interviews with Army community health nurses, who perform most TST administration and reading, there were anecdotal reports of continued use of the inferior multi-puncture test (MPT) until local stocks were depleted in order to save costs.

Discussion

Our review of the military's experience with TB demonstrates that the Army still faces old issues of exposure, surveillance, and control.

Extended deployments to a region of high TB endemicity has been associated with an increased risk of acquiring new TB infection and of acquiring active disease. No studies were found concluding that numerous short tours in areas of high endemic rates would result in an increased risk of infection.

The rate of active TB in the US Army closely parallels the rate of active TB in the United States. This is consistent with the studies showing that many soldiers with new infections acquired those infections before entering the service. One might expect that since the Army draws its recruits from the same general pool of Americans that the pattern of TB infection in the United States will determine to a large extent the pattern of TB infection in the US Army. Conclusions to be drawn from this data are limited in that crude rates were compared, ignoring many demographic differences between the Army and the general American population.

Growing up in an area of high endemicity was found to be associated with increased risk of disease or a positive TST result. This was true for newly enlisting soldiers and for dependents of soldiers. Many soldiers enter into longer-term conjugal relationships with individuals they meet while deployed overseas. Also, soldiers are commonly assigned to positions within or near their country of origin either by request or because of cultural or linguistic assets they bring as individuals to that post.

Inherent in peacekeeping and humanitarian missions is the deterioration of the local public health infrastructure. TB disease has been shown in other studies to be associated with developing countries, with unstable societies, and with mass refugee migrations[26]. This presents challenges to public health officers in the US Army in their efforts at health threat assessment.

The logistical challenges of administering and reading TSTs in preparation for and after return from a deployment have not yet been solved. While every attempt is made during soldier readiness processing (SRP's) for vaccines and other protective measures to be given to the soldier, there is often not enough time to review the record or obtain a TB exposure history or PPD test to medically clear the soldier before deployment. The result is an inability to establish a baseline rate of reactors during routine surveillance or in the context of an outbreak investigation. In addition, soldiers are usually granted leave immediately after return from a long overseas deployment, making post-deployment surveillance difficult to implement or monitor.

The use of differing preparations of PPD creates additional uncertainties in TB surveillance. It also makes historical comparisons less meaningful, with differing preparations and different TSTs.

Data could not be acquired on several recent conflicts because of the lack of systematic compilation and archiving of data. While data on active disease and known PPD converters is well maintained, the lack of good denominator data precluded any thorough study of deployments to the Persian Gulf, Somalia, and Haiti.

From the reference point of military medical readiness, TB does not pose a significant acute threat compared to other infectious diseases. However, the impact on medical and public health resources can be significant even with a single case of active disease. The surveillance infrastructure is currently insufficient to optimally monitor TB disease in active duty personnel.

Recommendations

Alternative methods of TB testing should be studied, with the goal of replacing the PPD test.

Uniform schedules of TB testing should be implemented, with the goal of improved capture of conversions over the current level. Consideration should be made to move to a yearly TB testing schedule for all personnel, similar to the Navy or Air Force.

Improvements are needed in the surveillance of TB during and after deployments. Better and more uniform training to those personnel who administer, read, and record the PPD must be instituted Army-wide. Better recording, compilation, and archiving of data will facilitate risk assessment for future deployments in the same region.

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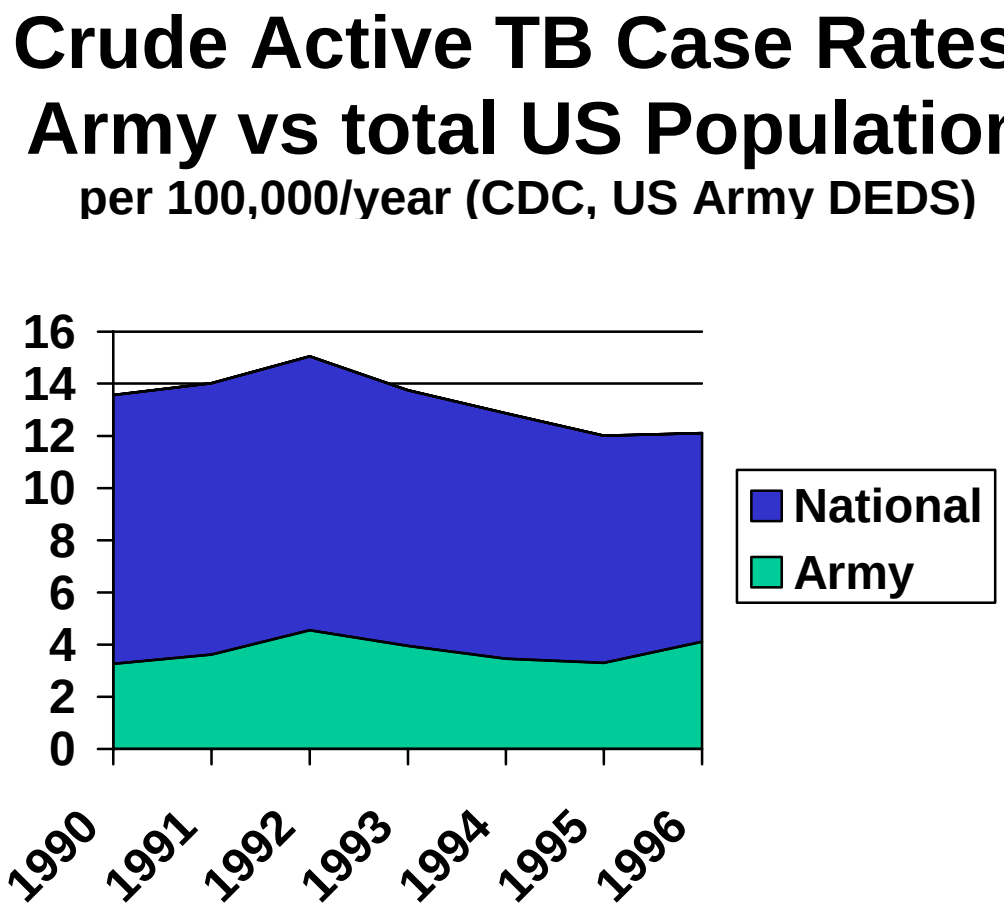
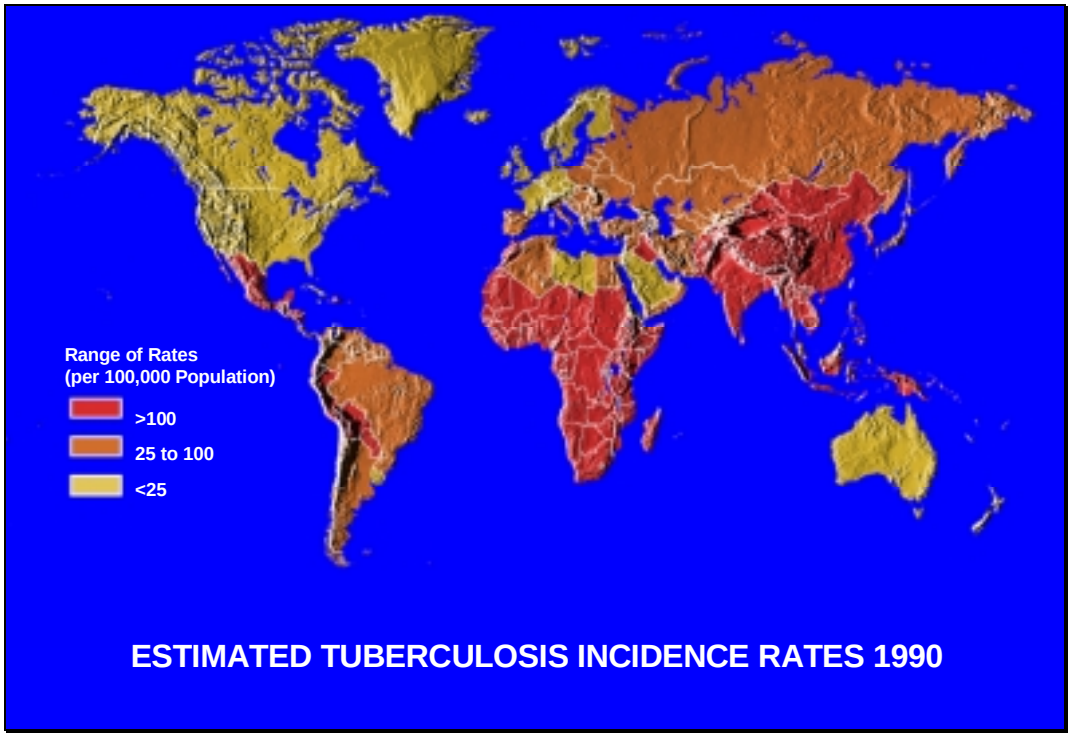
Graph

Fig 4. Annual incidence of Active TB Disease: US Army vs National Rates (per 100,000/year) While crude rates indicate TB is less of a problem in the Army than in the general population, more examination of high-risk groups is necessary. (source, CDC, US Army Disease Medical Surveillance System).



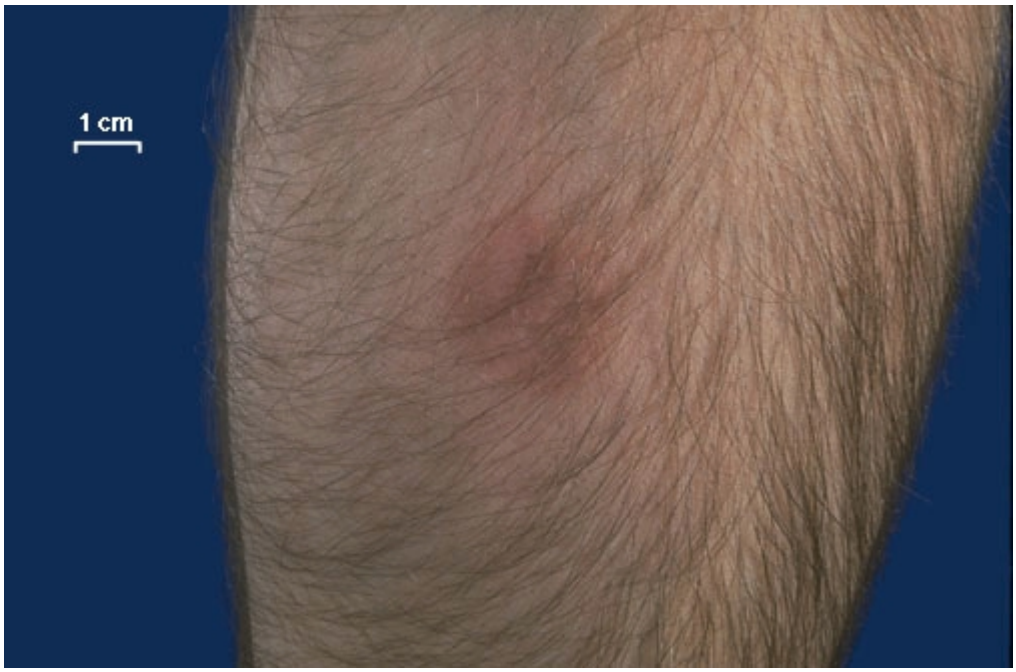
Map

Fig 5. Estimated Tuberculosis Incidence rates, 1990. Availability of data to determine potential risk of exposure to TB is dependent on the availability of local surveillance resources, which may extinguish in a combat situation. (Map source: Raviglione, et al. Global Epidemiology of Tuberculosis; Morbidity and Mortality of a Worldwide epidemic. *JAMA* 1995;273:220-226)



Picture of PPD on arm

Arm with reactive PPD test. Many of those in the Army whose MOS includes TST reading lack the requisite skills to accurately and precisely read the test. The poor sensitivity and specificity of the PPD, as well as the logistic difficulties of administering and reading it in a group that deploys on short notice presents several challenges to the military medical community. (Source: Edward C Klatt, University of Utah Division of Anatomic Pathology; http://www-medlib.med.utah.edu/WebPath. Reprinted with permission.)



Outbreaks Chart

Fig 2. Published Studies of Outbreaks of TB in the Military In a number of cases, confined cohorts of military personnel exposed to an active case of TB showed a resultant increase in the number of converters and active disease in the personnel exposed.

Service	Year	Location	time of exposure to index case	number potentially exposed	percent surveyed	secondary cases	TST conversion	Source
Army	1984	Ft Irwin, Ca	unknown	2971	83%	5 (0.2%)	34 (1.4%)	Ferraris
Navy	1966	Destroyer USS Richard E Byrd	6 months symptomatic	350	100%	7 (2%)	168 (48%)	Houk, et al
	1984	Amphibious Assault USS Saipan	3 months symptomatic	881	***	none	216 (24.5%)	DiStasio, et al

Rates of TB Chart

Fig 3. Published Studies on Rates of TB in the Military During different conflicts, there were cohorts such as Prisoners-of-War and Military Police that consistently had higher incidence of active disease. There were differing incidence of active disease by geographic region, with the Pacific Rim showing higher rates than those in the European theater.

Service	Time Period/Conflict	Source	Method of Testing	Cohort	Results
US Army	WWII	1958 OTSG Survey/report	General data collection	Army-wide	13,000 TB Hospitalizations 5,000 deaths Active disease rate: 1-1.75/1000 POWS: Japan 37/1000 Germany 6/1000
	WWII/Korea	1970 Study of POWs (Nefzger)	Longitudinal Cohort Study	US POWs in WWII, Korea	POWs in Pacific at significantly increased risk (1.15-2.4) for TB death compared to all POWs
	Vietnam	1969 Stead et al study	Analysis of US Army Surveillance Data	Army-wide	95% of troops arriving to Vietnam TST-negative
		1973 Sowell et al Study	Cohort cross-sectional study	US Army enlisted soldiers	4.9% 1-year conversion rate
		1970 20th Preventive Medicine Unit Study	Cohort analysis	Deployed units	6.2% of first-time personnel TST (+), compared to 13.7% of personnel starting second 1yr tour
		1970 Cowley Study	Cohort analysis	soldiers evacuated because of injury	3.3% conversion rate, average LOS 7 months
US Navy	1990 (end-strength)	Cross review of ppd testing	record review	All naval personnel	Higher frequencies of TST converters among personnel in Phillipines (3.1%), Japan (2.8%), Korea

					Japan (2.9%), Korea (2.0%), Guam (1.6%) and Okinawa (1.4%) compared to overall (0.97%) personnel on Pacific Ships (0.97%) with higher rates compared to Atlantic (0.62%)
US Air Force	1984-1987 (end-strength)	Parkinson 1987 review of USAF TB testing	record review	All Air Force personnel, retired personnel, dependents	Active Disease: Atlantic RMC's 3.4/100,000/year Pacific RMC's 65/100,000/year PPD conversion/1,000 tests placed and read: Active Duty: total 19.0 (18.9-19.1) (1.9%) CONUS: 18.0 (17.9-18.1) (1.8%) Pacific: 28.0 (27.6-28.4) (2.8%) Atlantic: 17.0 (16.7-17.3) (1.7%) Retirees and Dependants CONUS 22.8 (22.6-23.0) (2.3%) Pacific: 33.0 (32.4-33.6) (3.3%) Atlantic: 16.0 (15.5-16.5) (1.6%)

Pictures of Soldiers

Soldiers in deployments around the world. New missions such as refugee protection, humanitarian assistance, and peacekeeping have resulted in a new role, and new exposures, for US Army personnel.

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