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Hepatitis B seroprevalence in the U.S. military and its impact on potential screening strategies

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ABSTRACT

Introduction

Knowledge of the contemporary epidemiology of hepatitis B virus (HBV) infection among military personnel can inform potential Department of Defense (DoD) screening policy and infection and disease control strategies.

Materials and Methods

HBV infection status at accession and following deployment was determined by evaluating reposed serum from 10,000 service members recently deployed to combat operations in Iraq and Afghanistan in the period from 2007 to 2010. A cost model was developed from the perspective of the Department of Defense for a program to integrate HBV infection screening of applicants for military service into the existing screening program of screening new accessions for vaccine-preventable infections.

Results

The prevalence of chronic HBV infection at accession was 2.3/1,000 (95% CI: 1.4, 3.2); most cases (16/21, 76%) identified after deployment were present at accession. There were 110 military service-related HBV infections identified. Screening accessions who are identified as HBV susceptible with HBV surface antigen followed by HBV surface antigen neutralization for confirmation offered no cost advantage over not screening and resulted in a net annual increase in cost of \$5.78 million. However, screening would exclude as many as 514 HBV cases each year from accession.

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Conclusions

Screening for HBV infection at service entry would potentially reduce chronic HBV infection in the force, decrease the threat of transfusion-transmitted HBV infection in the battlefield blood supply, and lead to earlier diagnosis and linkage to care; however, applicant screening is not cost saving. Service-related incident infections indicate a durable threat, the need for improved laboratory-based surveillance tools, and mandate review of immunization policy and practice.

INTRODUCTION

The use of emergent whole blood transfusion has been an important feature of combat casualty resuscitative care in the recent military conflicts in Iraq and Afghanistan. The risk of transfusion-transmitted infections associated with this practice appears to be low.¹⁻³

The seroprevalence of hepatitis B virus (HBV) infection among military service members has not previously been determined. Current recommendations from the U.S. Centers for Disease Control and Prevention and U.S. Preventive Services Task Force are to screen persons at increased risk for infection and to perform periodic screening of those with ongoing risk who are not vaccinated.⁴⁻⁶ Current Department of Defense (DoD) policy states that applicants with current acute or chronic hepatitis or hepatitis in the preceding 6 mo do not meet the accession standard.^{7,8}

In 2012, the Department of the Navy expanded its accession entry screening of bloodborne pathogens to include HBV. All applicants to the Navy and Marine Corps are screened for chronic HBV infection and disqualified when screening results are confirmed.⁹ Army and Air Force regulations are consistent with the DoD policy but no population-level laboratory screening is performed in either service.^{10,11}

Universal HBV vaccination of new accessions into the military was initiated in 2002.¹² Current practice is to screen new accessions for the evidence of immunity to HBV and to immunize those identified as susceptible. In 1991, the Advisory Committee on Immunization Practices (ACIP) recommended universal vaccination of infants. Subsequent recommendations from the ACIP included (1) 1994: previously unvaccinated children aged 11 to 12 yr old and (2) 1997: all unvaccinated aged 0 to 18 yr.^{13,14}

We assessed the contemporary epidemiology of HBV in recently deployed military forces in order to identify the burden of infection in the force and the potential threat posed by HBV-infected personnel to the emergent, non-Food and Drug Administration battlefield blood supply. Findings are intended to inform potential screening strategies and the development of HBV infection control measures.

MATERIALS AND METHODS

Ethical Considerations

This investigation was endorsed by the Armed Services Blood Program Office and executed by public health, clinical, and research partners from each of the services in response to a formal tasking by the Joint Staff Surgeon to define the epidemiology of HBV and hepatitis C virus in the deployed

force. The Walter Reed Army Institute of Research Institutional Review Board reviewed the investigation protocol and determined that it was a public health activity and not human subjects research (no. 1822).

Seroepidemiology

A detailed description of the methods have been reported previously by Brett-Major et al.¹⁵ Briefly, a random sample of 10,000 Army, Air Force, Navy, and Marine Corps service members who ended their most recent deployment to combat operations in Iraq and Afghanistan from October 2007 through October 2010 and who had sufficient sera that had been collected at time points after deployment and at the time of service entry/accession and reposed in the DoD serum repository was identified and relevant archived deidentified personnel, deployment, and health data from the Defense Medical Surveillance System were obtained.¹⁶

Case Definitions

The following definitions of HBV infection were entered into the cost model: (1) probable chronic HBV infection (referred throughout as chronic HBV): both HBsAg positive and HBV deoxyribonucleic acid (DNA) positive, (2) possible chronic HBV infection: HBsAg positive, (3) immune to HBV infection due to vaccination: HBV surface antibody (HBsAb) reactive and HBsAg negative and HBV core antibody (HBcAb) nonreactive, (4) immune to HBV infection due to natural infection: HBsAb and HBcAb reactive and HBsAg negative, and (5) susceptible to HBV infection: HBsAb and HBcAb nonreactive and HBsAg negative. Borderline and missing results were assumed to be negative.

In addition, the following case definition of service-related incident HBV infection was utilized: possible incident HBV infection: HBV susceptible or vaccine-immune at accession and probable chronic HBV infection or immune due to natural infection at postdeployment time point.

Laboratory Measures

HBV infection status was determined in a stepwise fashion beginning with the evaluation of reposed serum at the post-deployment time point.¹⁵ Serum samples, stored at -30°C, were retrieved from the DoD serum repository. Serological testing of postdeployment samples was performed for antibody to hepatitis B core antigen (BIO-RAD MONOLISA Anti-HBc EIA, Hercules, CA), hepatitis B surface antibody (MONOLISA Anti-HBs EIA), and for hepatitis B surface antigen (HBsAg) (BIO-RAD GS HBsAg EIA 3.0). Due to the

limitations of available reposed serum, HBsAg neutralization was not performed. HBV nucleic acid testing was performed on samples that tested repeatedly reactive for HBsAg. HBV DNA was purified using QIAamp DNA blood mini kit (Qiagen Inc., Valencia, CA) and quantified using HBV ASR TaqMan reagents (Roche COBAS HBV, Roche Diagnostics Inc., Indianapolis, IN). When a postdeployment sample screened positive for the evidence of chronic HBV infection or immune to HBV due to natural infection, an accession sample was also tested under the same algorithm.

Statistical Methods

Prevalence rates of chronic HBV at postdeployment per 1,000 service members were assessed and 95% confidence intervals (CIs) were provided. Asymptotic CIs are reported; these are replaced by exact CIs when there are no cases or the lower limit of the asymptotic confidence interval is zero. In order to account for changes in ACIP HBV immunization recommendations and to account for differential vaccination coverage by time of entry into service based on birth year, data for service members born in or after 1979 were analyzed separately from those for members born before 1979. In addition, incidence rates for HBV per 1,000 service members were assessed for those service members who were susceptible, vaccine-immune, or identified as HBV-uninfected after deployment and did not have test results generated at the accession time point. Results are provided separately by whether or not the service member was accessioned before 2002. The rate of incident HBV infections per person-year was calculated as the total number of cases observed divided by the number of years from the later of initial entry time into either active or reserve/guard duty and the year of the postdeployment serum sample and converted to a rate per 100,000 person years. Data sets were managed and analyzed utilizing Statistical Analysis Software version 9.4 (SAS, Cary, NC).

Cost Modeling

We developed a decision tree reflecting three possibilities: (1) “status quo”- screen all applicants for the evidence of immunity with HBsAb and provide a complete 3 shot vaccine series to those without the evidence of immunity; (2) screen all applicants who screen negative for the evidence of HBV immunity for HBV infection with HBsAg and confirmation by HBsAg neutralization; (3) screen only those applicants born outside of the continental United States who screen negative for the evidence of HBV immunity for HBV infection with HBsAg and confirmation by HBsAg neutralization. A conservative cost model was developed using the observed estimate of chronic HBV infection rather than possible chronic HBV in order to avoid overestimating prevalence.

The following general assumptions impacted the construction of the cost model.

- With no applicant screening, accessions with chronic HBV infection will enter military service and generate health care costs.
- With either screening strategy (2) or (3) above, the number of accessions with chronic HBV infection who enter military service will be smaller than with no screening.
- Some applicants’ HBV infection status will be misclassified as screening is neither 100% sensitive nor specific.

Specific assumptions and inputs into the cost model were derived utilizing the seroprevalence observed in this study and various costs in 2015 U.S. dollars and relevant statistics drawn from within the DoD and the peer-reviewed scientific literature (Tables I and II). We assumed that the prevalence among all applicants would be the same as the prevalence observed among our study population.

We assumed that all applicants undergo HBV screening before accession. It is current practice to screen all new accessions for vaccine-preventable infections, including HBV, and to provide booster immunization as needed to individuals based on these results. It is not current practice to screen all applicants for immunity to vaccine-preventable infections. The assumption that HBsAb screening would be performed on all applicants (ie, “status quo”) was made for the purposes of this model. Based on review of recent historical data, the applicant pool size was assumed to be the sum of 232,000 accessions and 95,000 nonaccessions.¹⁷

We assumed a 40% (30.6%, 46.5%) prevalence of HBV immunity among applicants based on recent unpublished data obtained from public health authorities at selected Army and Air Force basic training sites (Susan Varner, Fort Leonard Wood, personal communication). We also assumed that all accessions who have chronic HBV infection would be identified during their period of military service and treated while in service. We assumed that 17% of accessions would serve 20 yr and that the remaining 83% would serve an average of 5 yr.¹⁸

We assumed all individuals with HBV infection would progress through a series of stages of HBV infection and disease states from immunotolerant through chronic infection, cirrhosis, hepatocellular carcinoma, liver transplant, and death using previously published estimates of disease state transition probabilities.¹⁹ All individuals identified as immunotolerant, with asymptomatic HBV infection, or evidence of seroconversion were assumed to get no treatment. Those with chronic HBV or compensated cirrhosis were assumed to be treated with tenofovir, a high-cost nucleotide with a low chance of developing resistance, every year until seroconversion or progression to more advanced disease states. Using previously published data,¹⁹ the annual rate of spontaneous conversion from immunotolerant and asymptomatic HBV was assumed to be 10%, and the annual rate of spontaneous conversion for individuals on therapy was assumed to be 21% save those with decompensated cirrhosis, where it was assumed to be 5%. Treatment costs for each disease state and tenofovir were

TABLE I. Model Inputs

Name	Base Case	Range	Distribution	Source
Demographic and test characteristics				
Prevalence of DNA-positive HBV detected at Screening	0.0023	(0.0018–0.0028)	Uniform	Current study
Surface antigen sensitivity	1.0	(1.0–1.0)	Uniform	BIO-RAD GS HBsAg EIA 3.0
Surface antigen specificity	0.998	(0.9973–0.9987)	Uniform	BIO-RAD GS HBsAg EIA 3.0
Surface antibody sensitivity	0.9926	(0.9852–1.0)	Uniform	BIO-RAD MONOLISA Anti-HBs EIA
Surface antibody specificity	0.963	(0.962–0.964)	Uniform	BIO-RAD MONOLISA Anti-HBs EIA
Enter asymptomatic carrier	0.35	(0.25–0.45)	Uniform	Eckman et al. ¹⁹
Stay 5 yr in service	0.83	(0.71–0.97)	Normal	Defense Business Board ¹⁸
Probability that a recruited service member passes medical screening and boot camp and proceeds to military service	0.71	(0.71–0.71)	Uniform	AMSARA ¹⁷
Detectable HBV immunity	0.4	(0.3–0.5)	Uniform	Susan Varner, personal communication
Probability of being foreign-born	0.077	(0.052–0.102)	Uniform	Current study
Prevalence of HBV infection in foreign-born	0.0128	(0.0078–0.0178)	Uniform	Current study
Markov model HBV disease progression probabilities				
Progression through stages of HBV infection (stratified by HBV DNA levels < 2 k, 2–20 k, and > 20 k) from immunotolerant through chronic infection, cirrhosis, hepatocellular carcinoma, liver transplant, and death using previously published estimates of disease state transition probabilities				Eckman et al. ¹⁹

DNA, deoxyribonucleic acid; HBV, hepatitis B virus; AMSARA, Accession Medical Standards Analysis and Research Activity.

TABLE II. Costs Used in Markov Model

Name	Base Case	Source
Rerecruitment costs	\$23,000	AMSARA, U.S. Army 2014
MEPS processing	\$690.82	AMSARA, U.S. Army 2014
Anti-HBs	\$4.50	MHRP, Personal communication
HBsAg	\$4.00	MHRP, Personal communication
HBsAg neutralization	\$30.00	MHRP, Personal communication
Vaccine	\$56.46	Air Force: Webber, B, Joint Base San Antonio; Navy: Beckett, C, Navy Bloodborne Infection Management Center, Personal communication
Tenofovir treatment	\$9,558.81	Eckman et al. ¹⁹
Chronic HBV	\$1,298.82	Eckman et al. ¹⁹
Compensated cirrhosis	\$1,460.26	Eckman et al. ¹⁹
Decompensated cirrhosis	\$19,550.87	Eckman et al. ¹⁹
Hepatocellular carcinoma	\$58,535.67	Eckman et al. ¹⁹
Transplant yr 1	\$192,938.03	Eckman et al. ¹⁹
Transplant yr 2+	\$33,693.65	Eckman et al. ¹⁹
Death	\$0.00	Current study

HBsAg, HBV surface antigen; HBV, hepatitis B virus; AMSARA, Accession Medical Standards Analysis and Research Activity; MHRP, U.S. Military HIV Research Program; MEPS, Military Entrance Processing Stations.

obtained from a previously published report and were inflated to 2015 U.S. dollars using the medical care component of the U.S. Consumer Price Index.¹⁹

Last, we assumed that applicants identified with chronic HBV through a screening program and not permitted to accession would have to be replaced with another fully qualified

individual and that this would incur rerecruitment costs of nearly \$23,000 per individual (Thomas J, U.S. Army Training and Doctrine Command, unpublished data).

The net cost of screening was determined by the cost of screening, the savings from avoiding treatment of those with HBV infection prevented from entering military service, and

the costs of rerecruiting and replacing applicants identified with positive HBV screening test results who are not allowed to enter.

Sensitivity analyses were performed using ranges of possible values for all assumed costs and probabilities using existing literature and personal communication. Our assumption that all accessions who enter military service with HBV infection would be identified before separation from service was compared with recent historical data.²⁰

RESULTS

Study Population

Of the 10,000 randomly selected service members, 9,993 had complete postdeployment HBV test results generated (Supplementary Table 1). Overall, most at accession were less than 25 yr old (73%), white (74%), males (89%), in the active component (76%), and in the Army (54%). This sample was representative of the applicant population.¹⁷

Birth and Accession Cohort Demographics

Among the study population, 3,850 (39%) were born before 1979 (older birth cohort). Those who were born in/after 1979 (younger birth cohort) were more frequently white (75% vs. 71%), of lower rank (95% vs. 81% were E01-E04), single (93% vs. 75%), in the Marine Corps (15% vs. 8%) and less likely to have health care occupations (2% vs. 5%) (Supplementary Table 2). Compared with those who entered military service before 2002 (24%), those who entered in 2002 or later were more likely to be younger (75% vs. 19% born in/after 1979), less educated (81% vs. 73% with a high school education or less), of lower rank (94% vs. 74% were E01-E04), serving in the active component (81% vs. 59%), Marines (14% vs. 6%), and less likely to have health care occupations (3% vs. 5%) (Supplementary Table 3).

HBV Cases—Postdeployment

There were 21 chronic HBV cases identified at the postdeployment time point; of these, 20 (95%) had some evidence of prior HBV infection present at accession. There were 26 possible chronic HBV cases present among service members tested at the postdeployment time point; of these, 14 (54%) had some evidence of prior HBV infection present at accession (Supplementary Table 1).

HBV Prevalence—Older Birth Cohort

There were 14 chronic HBV cases present at the postdeployment time point. Most cases were male (64%) and less than 30 yr old at accession (86%). Prevalence rates were highest among women (12/1,000, 95% CI: 1.5/1,000–22.4/1,000), service members of black race (12.9/1,000, 95% CI: 4.5/1,000–21.4/1,000) or other race (12.2/1,000, 95% CI: 0.3/1,000–37.3/1,000), sailors (7.4/1,000, 95% CI: 0.9/1,000–

13.9/1,000), and foreign-born service members (19.5/1,000, 95% CI: 2.6/1,000–36.3/1,000) (Supplementary Table 2). Of the 14 chronic infections at postdeployment, 11 were chronic (79%) at the time of accession, 2 were possible chronic at accession, and 1 had natural immunity at accession. At accession, the prevalence of chronic HBV was 3.9/1,000 (95% CI: 1.9/1,000–5.9/1,000).

HBV Prevalence—Younger Birth Cohort

There were 7 chronic HBV cases present at the postdeployment time point. Cases were more frequently male (71%), born in the continental United States (86%), soldiers (57%), and in the active component (71%). Six of 7 (86%) were either possible chronic (n = 1) or chronic (n = 5) at the time of accession. At accession, the prevalence of chronic HBV was 1.3/1,000 (95% CI: 0.4/1,000–2.2/1,000). Two of the 8 cases (25%) of chronic HBV infection at accession were identified among individuals born outside of the United States. Individuals born outside of the United States made up 8.4% of the total cohort of those born during/after 1979 (515/6,143). Prevalences were highest among those with race of “other” 5.1/1,000 (95% CI: 1.1/1,000–14.9/1,000) (Supplementary Table 2).

HBV Incidence

There were 110 possible incident HBV infections among the 9,780 service members uninfected at accession (Supplementary Table 3). Most incident infections resulted in immunity due to natural infection. Among those, there was one (1%) probable chronic HBV infection and 109 (99%) with the evidence of immunity due to natural infection. There were 75 susceptible at accession of whom 1 seroconverted to probable chronic HBV infection and 74 seroconverted to immune due to natural infection. And, there were 35 immune due to vaccination at accession who seroconverted to immune due to natural infection (Supplementary Table 1).

Costs—Screening Strategy No. 1

With no screening, the cost to the DoD of treating the estimated 534 cases of chronic HBV cases from a single year’s accession cohort of 232,000 was \$7.08 million.

Screening Strategy No. 2

The cost of screening all 327,000 applicants is \$0.78 million. Screening would identify 514 (96%) of the 534 cases of chronic HBV infection among the applicant population who accession, which would result in a treatment cost avoided of \$6.8 million. Thus, the total cost of treatment is reduced from \$7.1 million to \$0.26 million by a screening program that costs \$0.78 million. However, the additional \$11.82 million in recruiting costs required to replace these 514 applicants who do not accession results in a total cost of \$12.86 million.

Screening Strategy No. 3

The cost of screening only those 17,266 applicants born outside of the continental United States is \$0.08 million. Screening would identify 222 (42%) of the 534 cases of chronic HBV infection among the applicant population who accession, which would result in a treatment cost avoided of \$2.94 million. Thus, the total cost of treatment is reduced from \$7.1 million to \$4.14 million by a screening program that costs \$0.08 million. However, the additional \$5.11 million in recruiting costs required to replace these 222 applicants who do not accession results in a total cost of \$9.33 million. The status quo strategy of no screening results in the lowest overall cost to the DoD.

Sensitivity Analysis

The replacement, or rerecruitment cost, would need to be lowered to \$11,725 in order to make the screening strategy to screen all applicants cheaper than the status quo. The expected cost of treating each HBV infected case would need to increase to \$22,658 in order to make the screening strategy to screen all applicants cheaper than the status quo.

A Markov Chain Monte Carlo simulation was performed to simulate how frequently in a 1,000 simulation trials each screening option scenario is found to be the cheapest option. Using the distributions for all parameters in Tables I and II, the status quo, no screening was cheapest in 993 of 1,000 trials.

DISCUSSION

The overall prevalence of chronic HBV infection and the prevalence among the younger cohort of service members who were born after 1979 that was present at the time of accession into military service was 2.3/1,000 and 1.3/1,000, respectively. Thus, there are currently approximately 300 to 500 service members who enter the service each year with chronic HBV. The cost model is most strongly influenced by rerecruitment costs to replace an HBV-infected applicant identified through screening and the treatment costs to the DoD for a service member with chronic HBV. Screening for HBV infection at service entry would reduce chronic HBV infection in the force, may decrease the threat to the battlefield blood supply, and may lead to earlier linkage to care. However, applicant screening is not cost saving. As long as the replacement, or rerecruitment, cost is greater than the treatment cost, it will not be cost saving for the DoD to screen applicants for chronic HBV infection.

The observed overall prevalence at accession of 0.23% (23/9,993) is slightly lower than the estimated prevalence of HBV infection in the general U.S. population (0.3 to 0.5%).^{4,21,22} These data are consistent with U.S. national data with higher rates of infection among nonwhites, older individuals, and those born outside of the United States.

Among those born during/after 1979 and living in the United States, all would have been subject to infant/childhood

vaccination recommendations. The prevalence of chronic HBV infection at accession for the younger cohort was 0.13% (8/6,143). Observed prevalences were highest among nonwhites, though the absolute counts were small. Most cases were among those born in the United States, all of whom were subject to 1 or more recommendations for infant/childhood HBV vaccinations and may also have been immunized at service entry because universal immunization of new accessions was initiated in 2002. Only 25% (2/8) of the accession cases identified in this younger cohort occurred among individuals born outside of the United States. Individual exposure and risk behavior data were not available. Specifically, it is unknown what fraction of the U.S. born individuals in this younger cohort were vaccinated as children and/or were vaccinated on service entry, and it is unknown how many were children of immigrants from high prevalence countries, and/or were members of other groups at increased risk for HBV infection. Further study is required to determine risk factors for infection.

The accession prevalence among the older cohort, 0.39% (15/3,850), was higher. None would have been subject to infant/childhood vaccination recommendations in the United States but some may have been immunized at service entry or immunized during their period of service. Like the younger cohort, case counts were low. Observed prevalences were highest among nonwhites and among foreign-born. One-third (5/15) of the cases of HBV infection at accession were identified among those who were foreign-born. Here too, it is unknown what risk factors for HBV infection were present.

We assumed that all of those who entered military service with chronic HBV infection would be identified and linked to care before separation from military service. Actual case finding of chronic HBV infection appears to be much less than 100%. Many service members with chronic HBV infection likely enter, complete service, and separate without having their infection status identified. Case finding of less than 100% results in lower treatment costs to the DoD, so screening is likely to be even more unfavorable in terms of cost than this model would suggest.

The U.S. military screens all new accessions for the evidence of HBV immunity and vaccinates all those with laboratory evidence of susceptibility with a complete 3 dose vaccine series in order to prevent incident HBV infection. Postvaccination serologic testing for immunity is not routinely performed in military personnel.

In this investigation, the rate of incident HBV infections was 189/100,000 PY's, which is considerably higher than that reported among active duty personnel in the period 2007–2016 (126/yr, 10/100,000 person-yr).²⁰ However, direct comparison of these rates is difficult because rates from this study are based on infection rates among all individuals at risk, whereas previously reported rates were based only on those that were identified clinically, which is likely a significant underestimate since the vast majority of acute HBV infections

in adults are asymptomatic. These data suggest that incident HBV infection remains an enduring threat in this population.

There are some potential challenges associated with these incidence data. False-positive test results would contribute to an overestimation of incidence, particularly among those based on the presence of a positive HBcAb because this test has a high false-positive rate.²³ Future study is warranted in order to more accurately characterize incident HBV infection in this highly vaccinated population of young adults. This is also of great interest in terms of examining the impact of immunization on this population of whom most (61%) were subject to infant/childhood vaccine recommendations and most (76%) were subject to universal HBV immunization of new accessions.

Current data from a variety of settings suggest that protection from HBV infection following a complete immunization will last for 30 yr or more.²⁴ Specific areas of interest to explore for the DoD include defining the duration of immunity from childhood vaccination during the period of service and defining the duration of protection after adult vaccination/revaccination and determining if a single booster would provide adequate protection. An examination of current HBV immunization policy in the DoD is warranted and may inform the development of other cost beneficial means to optimize existing HBV immunization practices. For example, screening accessions for immunity and providing a single booster dose to those who are susceptible with follow-up testing may be a strategy to consider reducing unnecessary immunization and reduce cost given the fact that a significant fraction of previously vaccinated adults with waning immunity show the evidence of immunity following a single booster shot.²⁵

Because the majority of all HBV infections among U.S. military personnel were present at accession, an applicant screening program is likely to be the most effective way to decrease the burden of HBV infection and to decrease the threat to the emergency battlefield non-Food and Drug Administration blood supply. Screening would also likely result in opportunities for earlier diagnosis and linkage to care. Accession screening would markedly reduce the burden of HBV infection but would not eliminate HBV infection due to low-level service-related incidence. However, accession screening is predicted to result in no net cost-benefit to the DoD and would result in a substantial net cost. If the HBV infection treatment landscape changes substantially such that treatment costs markedly increase, this analysis should be repeated. Opportunities exist to optimize HBV infection control measures and may benefit from more complete characterization of incident infections. Further study is warranted. Improvements in the performance of diagnostic tools available for the determination of HBV infection status would improve surveillance and public health efforts.

SUPPLEMENTARY MATERIAL

Supplementary material is available at *MILMED* online.

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