Pertussis Diagnoses among Service Members and Other Beneficiaries of the U.S. Military Health System, January 2005-June 2012

Pertussis ("whooping cough") is a highly infectious respiratory disease caused by the bacterium *Bordetella pertussis*. Individuals at highest risk are infants and unvaccinated children; however, there have been recent increases in incidence among adolescent and young adult populations in the United States. During the surveillance period, there were 476 confirmed and 3,073 probable cases of pertussis among U.S. military members and other beneficiaries of the U.S. Military Health System. Among service members there were 77 and 13 confirmed cases in active and reserve component members, respectively. In comparison, infants and children aged 15 years and younger accounted for over half of all confirmed cases (n=244). Several spatiotemporal clusters of pertussis among military healthcare beneficiaries were associated with outbreaks in adjacent non-military communities, particularly in five states (California, Texas, Florida, Washington, and New York); one cluster occurred in a military community in Okinawa, Japan.

Pertussis ("whooping cough") is a highly infectious respiratory disease that is commonly known as a disease of childhood. It is caused by the bacterium *Bordetella pertussis*. The clinical course of pertussis begins with upper respiratory tract symptoms (cough, runny nose, mild fever) lasting one to two weeks; this stage is followed by the development of severe coughing episodes (paroxysms) that typically involve a characteristic "whoop" upon inspiration. Recovery from pertussis is prolonged; affected individuals usually experience a persistent cough that takes weeks to months to resolve.[1]

Pertussis is vaccine preventable; yet, thousands of cases and many outbreaks are reported each year in the United States. Individuals at highest risk are infants and unvaccinated children. However, since the 1980s an increasing incidence of pertussis in children aged 7 to 10, adolescents, and young adults has suggested an epidemiologic shift in pertussis disease burden to include individuals with waning immunity. Immunity associated with receipt of pertussis vaccine diminishes over time and this decline may be more rapid in persons vaccinated with acellular vaccines in childhood.[1-3] Other factors contributing to this shift include enhanced surveillance during outbreaks, increased awareness among the general population about the disease (e.g., through media reports), higher index of suspicion among clinicians, and improved laboratory testing.[1]

This report summarizes the numbers, trends, and demographic characterstics of pertussis diagnoses among service members and other beneficiaries of the U.S. Military Health System. Several spatiotemporal clusters of pertussis are identified.

METHODS

The surveillance period was 1 January 2007 through 30 June 2012. The surveillance population consisted of all individuals who are beneficiaries of the U.S. Military Health System, i.e., active and reserve component service members, retired service members, family members and other dependents of service members and retirees, and other authorized government employees and family members. For this report, a confirmed case was defined as an individual identified through a reportable medical event of pertussis. A probable case was defined by a hospitalization or ambulatory encounter with a diagnosis of pertussis (ICD-9-CM: 033) in the primary diagnostic position. Such encounters were excluded if there was either: 1) a record of pertussis vaccine administration or a positive test for serologic immunity to pertussis within seven days before or after the encounter date; or 2) a diagnostic or procedural code indicating pertussis vaccination during the encounter **(Table 1)**.

RESULTS

During the surveillance period, there were 476 confirmed and 3,073 probable cases of pertussis among U.S. military members and other beneficiaries of the U.S. Military Health System **(Figures 1,2)**. Approximately 81.1 percent (n=386) of confirmed cases and 89.9 percent (n=2,762) of probable cases affected non-military members ("other beneficiaries") **(Figures 1,2)**.

Among those individuals whose ages were reported (93% and 99% of confirmed and probable cases, respectively), 38.5 percent of confirmed cases (n=171) were infants and children aged 10 years and younger (44.3% [n=1,348] in probable cases) **(Figure 3)**. An additional 23.9 percent of confirmed cases (n=106) occurred in individuals aged 11 through 20 years (12.2% [n=371] in probable cases). The remaining 37.6 percent of confirmed cases (n=167) were distributed across the adult age groups (43.5% [n=1,324] in probable cases) **(Figure 3)**. There were 253 males and 221 females

TABLE 1. Diagnostic and procedural codes used to exclude medical encounters related to pertussis vaccination

ICD-9-CM	V03.6, V06.1, V06.2, V06.3, 99.37, 99.39
Outpatient procedure codes (CPT)	90698, 90700, 90701, 90715, 90720, 90721, 90723

FIGURE 1. Confirmed and probable cases of pertussis, active and reserve service members U.S. Armed Forces, January 2007-June 2012

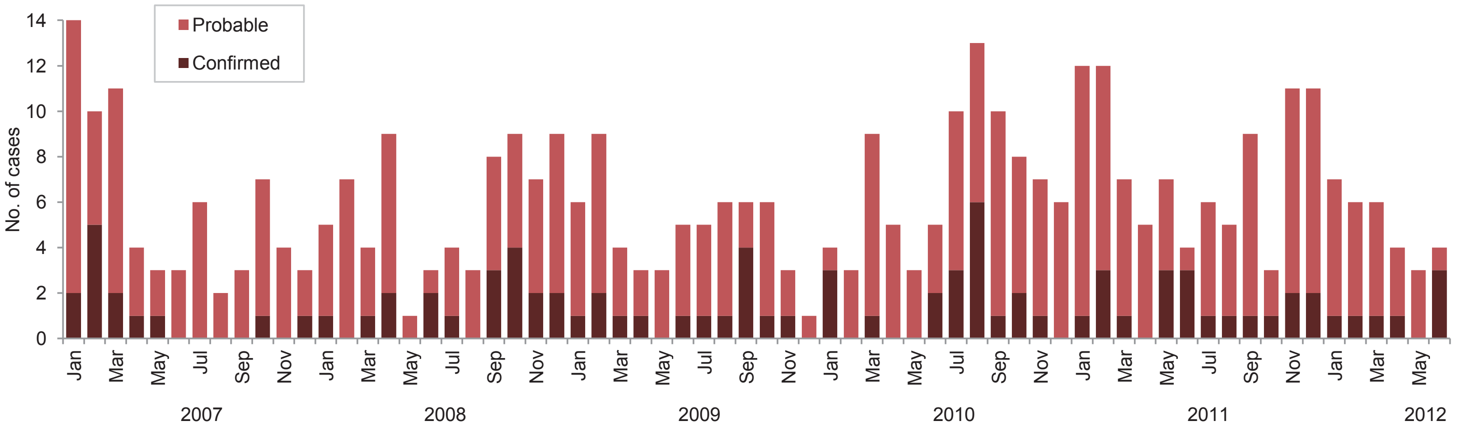


FIGURE 2. Confirmed and probable cases of pertussis among non-service member beneficiaries of the U.S. Military Health System, January 2007-June 2012

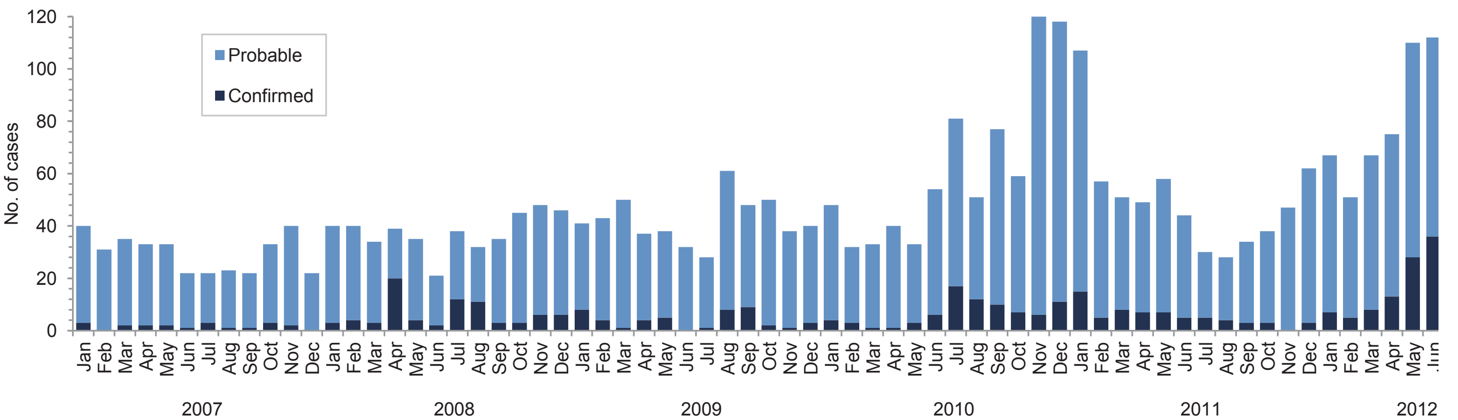
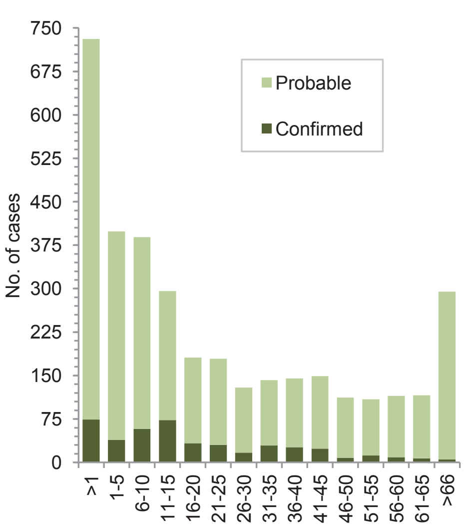


FIGURE 3. Age distribution of confirmed and probable pertussis cases,[a] January 2007-June 2012



[a]Age not available for 32 confirmed and 30 probable cases

among the confirmed cases whose gender was recorded **(data not shown)**.

During the surveillance period, five states, California (CA), Texas (TX), Florida (FL), Washington (WA), and New York (NY) and one country, Japan, had 18 or more cases (confirmed and probable combined) within one month periods ("spatiotemporal clusters") **(Figure 4)**. Within these states (and country), 7 installations or medical facilities reported 12 or more pertussis cases within one month periods. Naval Hospital (NH) Jacksonville, FL and NH Oak Harbor, WA had spatiotemporal clusters in April 2008 and July 2008, respectively. Naval Medical Center (NMC) San Diego, CA and Camp Pendleton, CA had clusters from July 2010 to February 2011. Since March 2012, NH Oak Harbor, WA, Joint Base Lewis-McChord, WA, and Fort Hood, TX have experienced spatiotemporal clusters **(Figures 5,6)**.

Most recently, NH Okinawa, Japan reported 11 cases in May 2012 and 25 cases in June 2012; 17 of these cases (47.2%) were confirmed. Of all cases, 21 (58.3%) were in beneficiaries in the age group of 11 to 15 years **(data not shown)**.

EDITORIAL COMMENT

Pertussis vaccination is required for entry into military service; however, pertussis can still occur in vaccinated individuals due to waning immunity or primary vaccine failure. During the 5-year surveillance period, 77 confirmed cases (16.2%) occurred in the active component and 13 confirmed cases (2.7%) in the reserve component. In

FIGURE 4. States/countries with 18 or more pertussis cases (confirmed and probable combined) during any calendar month, January 2007-June 2012

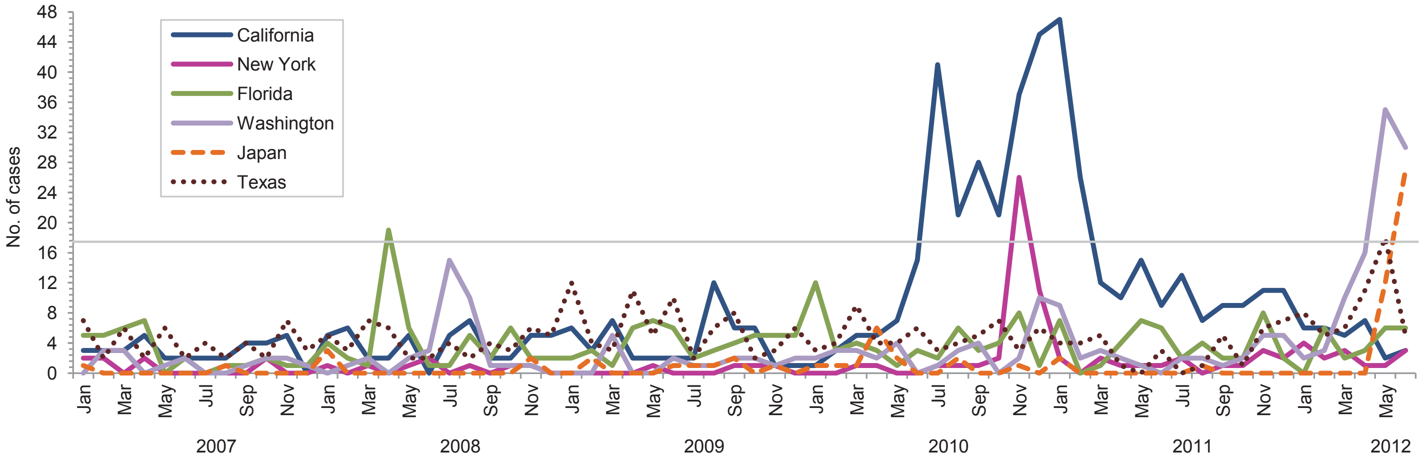
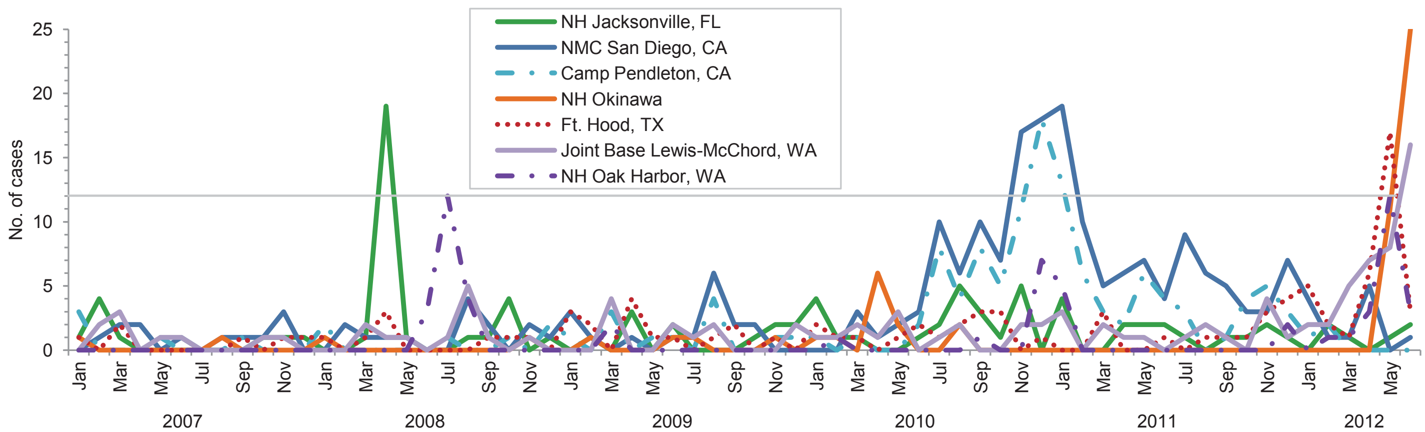


FIGURE 5. Installations/medical treatment facilities with 12 or more pertussis cases (confirmed and probable combined) during any calendar month, January 2007-June 2012

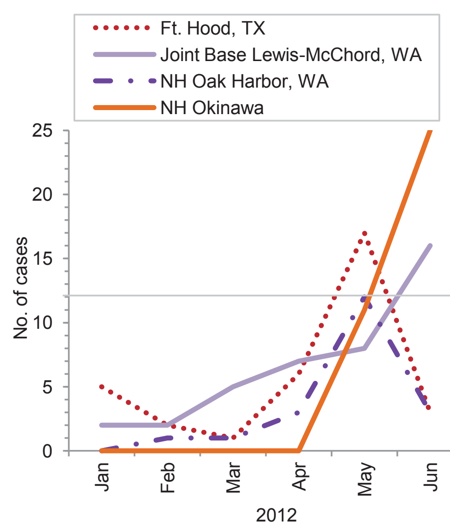


comparison, infants and children aged 15 years or younger accounted for over half of all confirmed cases (n=244, 55.0%). Furthermore, infants younger than 1 year and adolescents aged 11 to 15 years reported the highest numbers of confirmed cases (n=74 [16.7%] and n=73 [16.4%], respectively). These data, along with several reports of recent pertussis outbreaks, demonstrate that the epidemiologic profile of pertussis has shifted to include more members of the adolescent and young adult populations.[2,3]

Several of the military spatiotemporal clusters were associated with outbreaks in adjacent nonmilitary communities. In 2008, the Florida State Public Health Department reported higher numbers of cases in 10 out of 12 months compared to the 5 year average.[4] NH Jacksonville recorded a spatiotemporal peak in April of 2008; the county encompassing Jacksonville reported some of the highest rates of pertussis during 2008.[4]

In 2010, the California Department of Public Health reported a 12-fold increase in pertussis cases compared to 2009; at that time, California did not require a pertussis booster shot for middle school students.[1,5] However, since the fall of 2011, California has required, by law, recent pertussis booster vaccinations in middle school and high school students.[1] In this report, NMC San Diego and Camp Pendleton experienced spatiotemporal clusters of cases from July 2010 through February 2011. New York State also reported increases in pertussis during this period and urged vaccination

FIGURE 6. Installations/military treatment facilities with 12 or more pertussis cases (confirmed and probable combined) during any calendar month, January-June 2012



in infants and children and booster doses for adolescents and adults.[6]

More recently, in May and June of 2012, several states have reported outbreaks of pertussis. Washington State declared a pertussis epidemic in April 2012; by mid-June the state had recorded 2,520 cases, a 1,300 percent increase compared to the same period in 2011.[3,7] NH Oak Harbor and Joint Base Lewis-McChord both demonstrated increases in cases during March through June 2012; these locations are in counties (Island and Pierce, respectively) that reported some of the highest rates of pertussis in the state in 2012.[7]

On 31 May 2012, the U.S. Naval Hospital in Okinawa, Japan released a public announcement reporting several confirmed cases of pertussis in the U.S. military community on Okinawa.[8] Cases have been identified in both adolescents and adults. From January 2007 to March 2012 (i.e., 63 months), NH Okinawa reported a total of nine cases with no more than two cases reported in a single month. In May and June 2012, Okinawa reported 11 and 25 cases, respectively.

During any outbreak situation, there is an increased awareness of the disease in the community and among clinicians; therefore, individuals may be more likely to seek care and clinicians more likely to suspect, test, diagnose, and report the disease. Therefore, "spatiotemporal clusters" reported here may not only reflect an increase in actual disease, but also enhanced surveillance.

A majority of the cases in this report were categorized as probable cases. In the U.S. Military Health System, pertussis is a reportable medical event; therefore, "true" cases (i.e., cases that meet the case definition) of pertussis should be reported through this system. However, many cases may not be properly reported, or reported elsewhere (e.g. state health department) particularly if associated with care given outside the Military Health System ("out-sourced" care) or if laboratory or pertinent patient history is unavailable or pending.

Recent trends in pertussis in both military and civilian populations in the U.S. highlight the importance of primary and booster vaccinations against pertussis. The modern acellular vaccine for pertussis is less frequently associated with local and systemic reactions than the predecessor whole-cell vaccine. Current recommendations for pertussis vaccine include 5 doses between ages 2 months and 6 years, one dose for those 11 to 18 years (preferably at age 11 or 12), and one dose for any adult who has never received the acellular vaccine. The recommendation for adults is especially pertinent to health care personnel who have direct patient contact during which they may be exposed to pertussis from their patients or may transmit the bacterium to patients.

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Hospitalizations for Hepatitis A, B, and C, Active Component, U.S. Armed Forces, 1991-2011

Although genetically quite distinct from one another, hepatitis viruses A, B, and C all cause inflammatory liver disease (hepatitis) in humans. Hepatitis A virus (HAV) is spread through fecal-oral transmission and has a long history as an important cause of disease in military populations. Hepatitis B and hepatitis C viruses (HBV and HCV, respectively) are both spread by percutaneous or mucous membrane exposure to infected blood or body fluids and therefore have similar risk factors (e.g., unprotected sex with an infected partner, intravenous drug use, transfusion of contaminated blood).

Screening and immunization programs implemented in the United States and in the U.S. Armed Forces have had major beneficial effects on the incidence of new infections caused by these hepatitis viruses, especially types A and B. Hospitalization data is available from the Defense Medical Surveillance System (DMSS) starting in 1990. This report describes hospitalization trends of hepatitis types A, B, and C during a 21-year period (1991-2011) against the backdrop of important strides in the prevention of hepatitis disease.

HAV

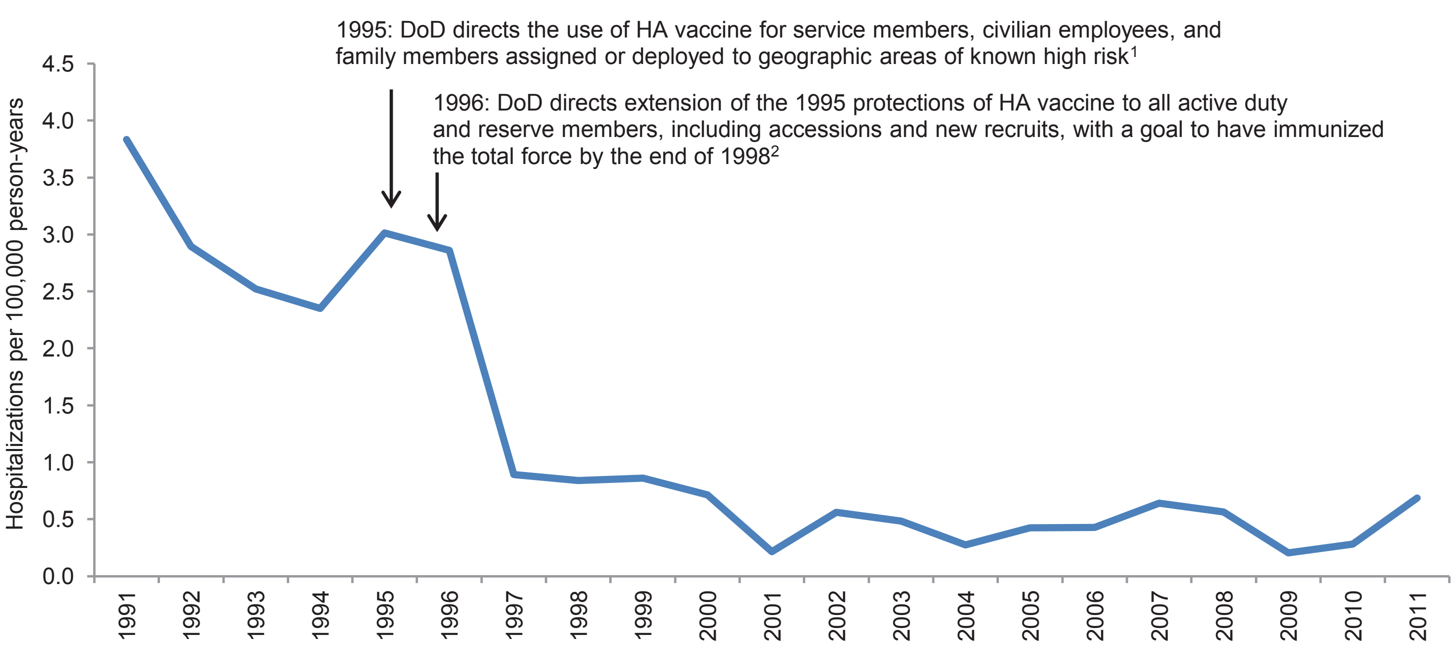
Hospitalizations for acute hepatitis A were identified by International Classification of Diseases, 9th Revision, Clinical Modification (ICD-9-CM) diagnoses codes 070.0 or 070.1 in any diagnostic position. From 1991 to 2011, there were 415 hospitalizations for acute hepatitis A among active component members of the U.S. Armed Forces; the crude overall hospitalization rate during the period was 1.3 per 100,000 person-years (p-yrs) **(Figure 1)**. Annual hospitalization rates of acute hepatitis A fell dramatically following the implementation of the Department of Defense's 1995 and 1996 policies for use of hepatitis A vaccine in the Armed Forces.[1,2] The recent low hospitalization rates of acute hepatitis A among U.S. military members (range for 2000-2011: 0.2 to 0.7 hospitalizations per 100,000 p-yrs) likely reflect not only recruit screening and immunization but also the widespread use of hepatitis A virus vaccine among children and adolescents in the United States.

HBV

Hospitalizations for hepatitis B were identified by ICD-9-CM codes 070.20, 070.21, 070.30, or 070.31 (acute) or 070.22, 070.23, 070.32, 070.33, or V02.61 (chronic) in any diagnostic position. From 1991 to 2011, there were 820 and 241 hospitalizations of active component members for acute and chronic hepatitis B virus infections, respectively; crude overall hospitalization rates during the period were 2.4 (acute hepatitis B) and 0.7 (chronic hepatitis B) per 100,000 p-yrs **(Figure 2)**.

Annual hospitalization rates for acute hepatitis B declined by 88 percent from 1992 to 1997 (8.7 and 1.0 per 100,000 p-yrs, respectively) and were relatively stable over the next 14 years; the rate in 2011 was lower (0.7 per 100,000 p-yrs) than in any other year of the period. Following the creation of a new ICD-9 code for chronic hepatitis B in late 1994, rates of hospitalizations for chronic hepatitis B increased to 2.2 per 100,000 p-yrs in 2001 and slowly

FIGURE 1. Trend of incident hospitalizations for hepatitis A , active component, U.S. Armed Forces, 1991-2011



declined to their lowest levels ever in 2010 and 2011 (0.3 and 0.7 per 100,000 p-yrs, respectively).

The decline in hospitalizations for acute hepatitis B in the U.S. military during the 1990s likely reflects an increased prevalence of hepatitis B immunity among service members resulting from HBV childhood vaccination campaigns in the United States. Declines after 2002 likely reflect the combined effects of immunization prior to entry into service as well as the 2002 implementation of the DoD policy for screening and vaccination of immunologically naive recruits.[3] The gradual decrease in hospitalization rates for chronic hepatitis B probably represents, at least in part, delayed effects of the factors that have decreased acute hepatitis B incidence.

HCV

Hospitalizations for hepatitis C were identified by ICD-9-CM codes 070.41 or 070.51 (acute) or 070.44, 070.54, 070.70, 070.71, or V02.62 (chronic) in any diagnostic position. From 1991 to 2011, there were 737 and 899 hospitalized cases of acute and chronic hepatitis C, respectively, among active component members of the U.S. Armed Forces; crude overall rates during the period were 2.3 (acute) and 2.7 (chronic) per 100,000 p-yrs **(Figure 3)**. Hospitalization rates of acute hepatitis C diagnoses steadily declined (by 80%) from 1994 to 2000 and then again from 2004 to 2011 (by 97%). Rates of chronic hepatitis C hospitalizations declined from 1995 to 2000 (by 67%). From 2001 to 2011, hospitalization rates for chronic hepatitis C remained relatively stable, ranging from 2.5 per 100,000 p-yrs (2002) to 4.4 per 100,000 p-yrs (2008).

There is no vaccine for hepatitis C; thus, other factors must account for the declines in rates of hospitalization for acute and chronic hepatitis C documented here. First, there were no ICD-9-CM diagnostic codes specific for hepatitis C prior to October 1991 or for chronic hepatitis C until October 1994. As such, during the early years of the surveillance period, hospitalizations for hepatitis C-related illnesses could not be ascertained from the hospitalization records used for this report. Second, a reliable test for HCV infection (a test for antibody to the virus) was not widely available until approximately 1992. As a result, laboratory confirmation of HCV infection was not generally possible until after that time. Third, many individuals who are infected with HCV, especially those who are chronically infected, are asymptomatic; thus, in the early 1990s, absent other indications, asymptomatic individuals were unlikely to be tested. The asymptomatic HCV infections of service members may have been identified eventually, e.g., when attempting to donate blood, which was routinely screened for hepatitis C after 1991, or during other medical evaluations. Thus, the initial identification of persons already infected in 1991 may have been distributed over subsequent years. Fourth, the confirmation of a diagnosis of chronic hepatitis C in the 1990s depended in part on documentation that the patient's "acute" infection had not resolved over a period of six months or more following initial detection of the infection. As a result, it is not surprising that the peaking of cases of chronic

FIGURE 2. Trend of incident hospitalizations for acute and chronic hepatitis B, active component, U.S. Armed Forces, 1991-2011

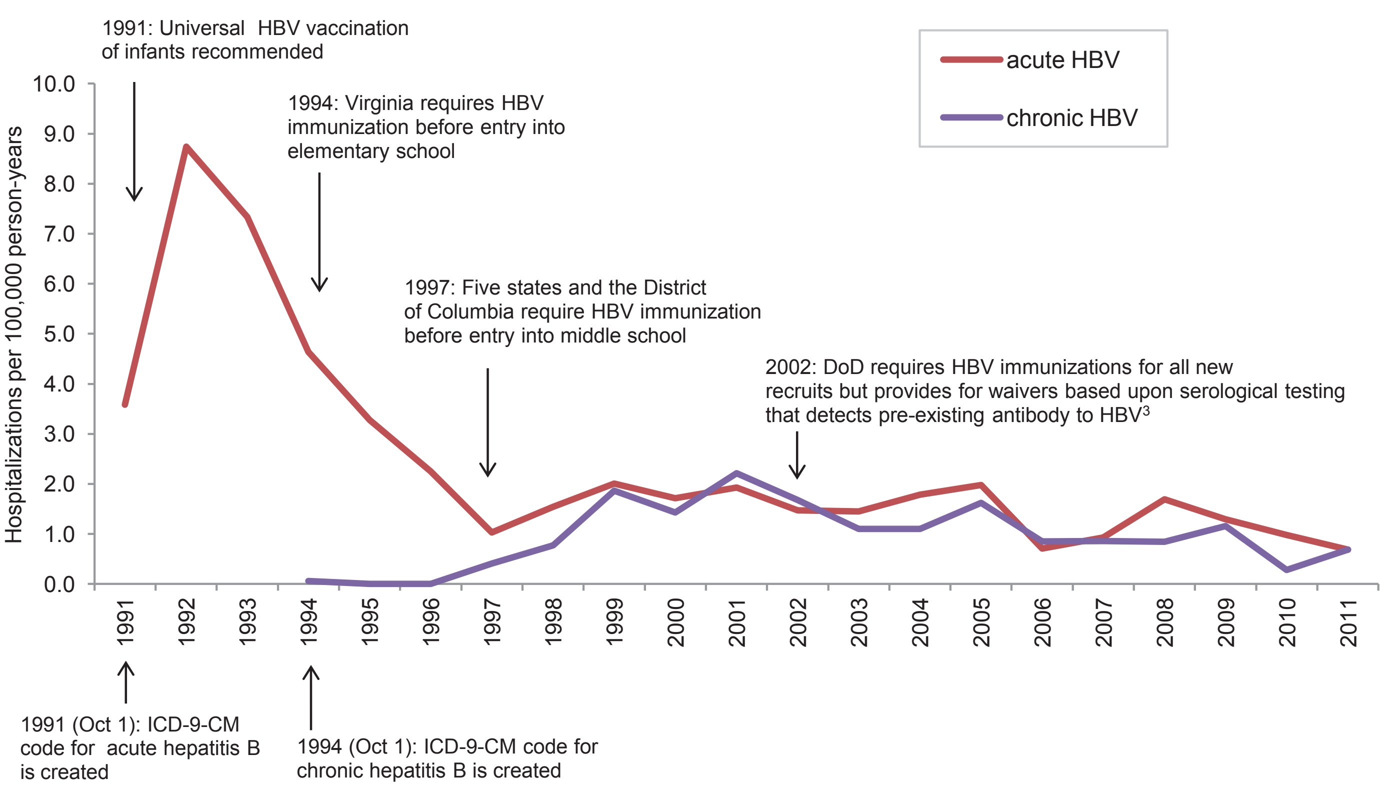
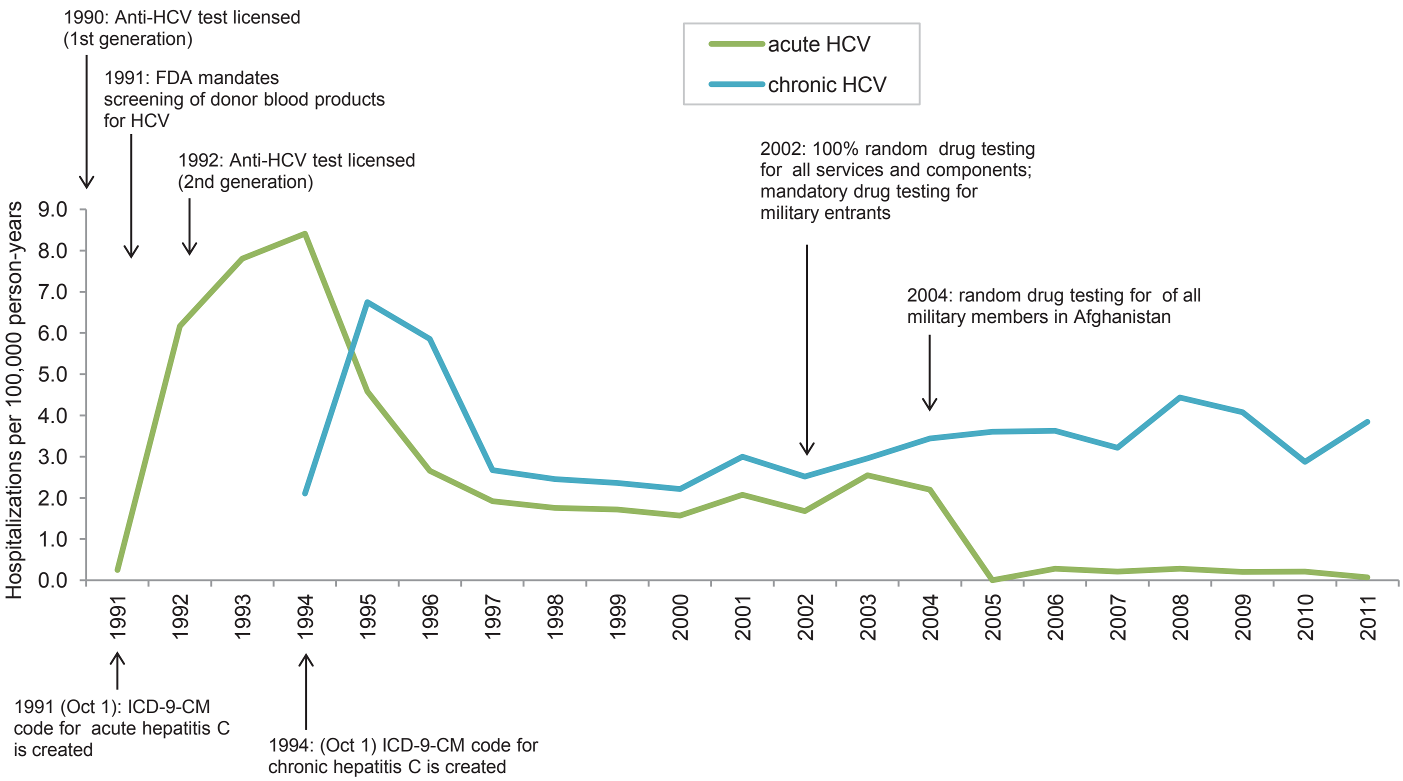


FIGURE 3. Trend of incident hospitalizations for acute and chronic hepatitis C, active component, U.S. Armed Forces, 1991-2011



hepatitis C lagged behind initial diagnoses of acute hepatitis C. Lastly, as many as 80 percent of cases of acute hepatitis C go on to develop persistent infection that leads to chronic hepatitis C. Accordingly, any changes in the incidence of acute hepatitis C will likely be followed by corresponding changes in the incidence of chronic hepatitis C. In summary, as a result of the factors described above, the peak in hospitalizations for acute hepatitis C in the early 1990s was occasioned by the introduction of laboratory tests that enabled detection of HCV infections and ICD-9-CM codes that permitted the documentation of HCV-specific diagnoses in standardized medical records.

Since the late 1990s, the hospitalization rates for both acute and chronic hepatitis C have been relatively stable except for the precipitous and lasting drop in the rates for acute hepatitis C beginning in 2005. A previous *MSMR* report described a downward trend in combined inpatient and outpatient diagnoses of acute hepatitis C since 2000, particularly beginning in 2005.[3] The paucity of hospitalizations since then suggests that recent health care practices have deemphasized the need for inpatient evaluations and management of acute hepatitis C.

The last decade's declines in the incidence of both acute and chronic hepatitis C are most dramatic for service members aged 40 and older. For example, in 2000, the rate of diagnosis of acute hepatitis C was more than fourfold higher among members 40 years and older compared to any younger age group; in 2010, the rates in all age groups were approximately the same. In 2000, the rate of diagnosis of chronic hepatitis C was approximately fivefold higher among service members 40 years and older compared to any younger age group; in 2010, the rate among 40 years and older service members was only about two and a half times that among younger service members.[4]

HBV and HCV in the era of HIV

Because HBV and HCV share risk factors with human immunodeficiency virus (HIV), measures aimed at preventing acquisition and transmission of any one of these viruses can have beneficial impacts on transmission of the others. Since the early 1990s, all donated blood has been screened for the presence of all of these viruses. Not only does the identification of infective blood preclude its transfusion into others, but the recognition of presumably "silent infections" in donors can enable such individuals to avoid unwitting transmissions of life threatening infections to others (e.g., sex partners).

The periodic screening of military service members for HIV antibody identifies persons infected with HIV, who may be at high risk of infection with HBV or HCV. As such, counseling of HIV infected individuals may reduce their risk of acquiring HBV or HCV or transmitting HIV, HBV, or HCV. Increased awareness among service members in general about behaviors that increase risk of acquiring HIV infection (e.g., unprotected sex with infected partners, illicit drug use) should contribute to the prevention of HBV and HCV acquisitions by them. When applicants for military service are screened for drug abuse, HIV infection, and recent history of hepatitis, the exclusion of those who screen positive reduces the prevalence of service members with risk factors for these viral infections. For service members, the performance of randomized and ad hoc drug screening, periodic HIV testing, and periodic health and medical examinations all serve not only to detect individuals at risk but also to sensitize and educate service members about the risks for these diseases. Lastly, in the health care setting, the widespread application of universal blood and body fluid precautions reduces the risks of transmitting these three viruses to patients and to health care workers.[4,5]

There are several limitations to this report that should be considered when interpreting the results. First, trends in rates of hospitalization over time may reflect differences in case management for acute and chronic hepatitides and changes in hospitalization guidelines within the military health system. Second, the summary of hospitalization rates reported here is not as comprehensive as the previously cited report that utilized both inpatient and outpatient health encounters.[4] However, because this report focused on hepatitis-specific hospitalizations, it was able to assess hepatitis incidence among U.S. military members since 1991 (electronic records of outpatient encounters of U.S. military members have been centrally collected and archived since 1997). Third, while the vaccines against HAV and HBV played major roles in the declining incidence rates of these diseases among active component members, the decline in HCV incidence reflects the effects of several factors. The relative impacts on HCV incidence of the factors described above are difficult to discern from available data; it is clear, however, that HCV disease among active component military members has sharply declined over the past two decades.

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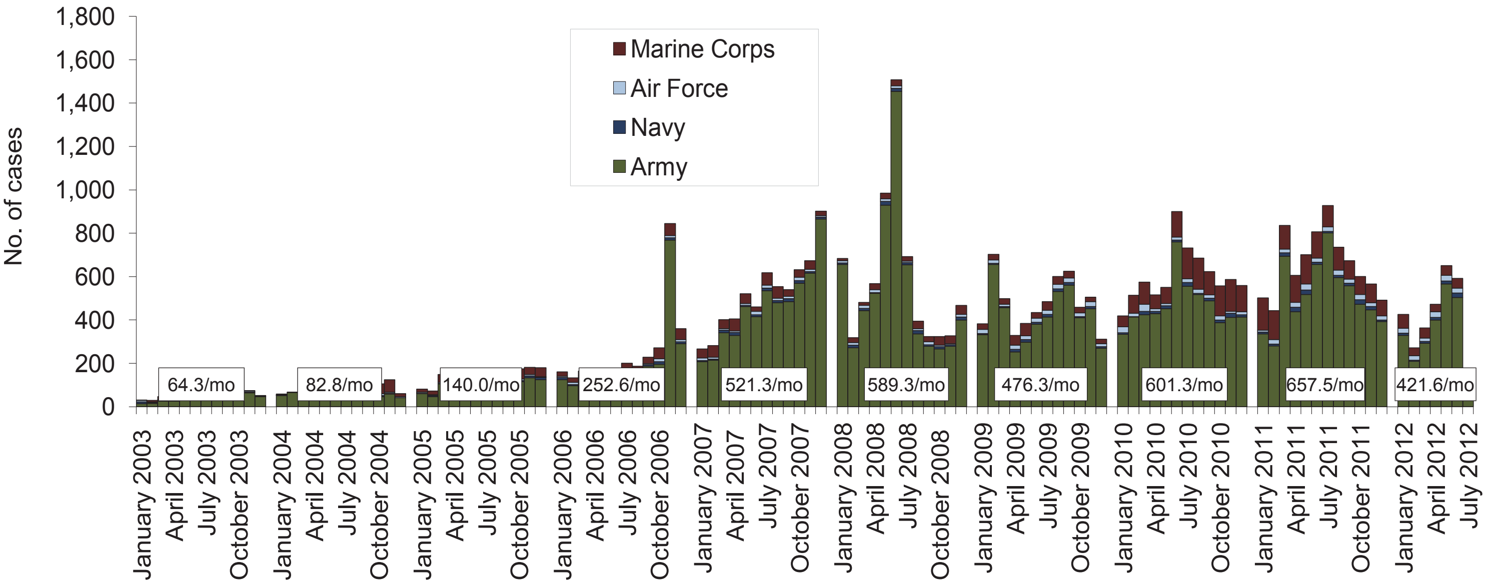
Deployment-related conditions of special surveillance interest, U.S. Armed Forces, by month and service, January 2003-July 2012 (data as of 26 August 2011)

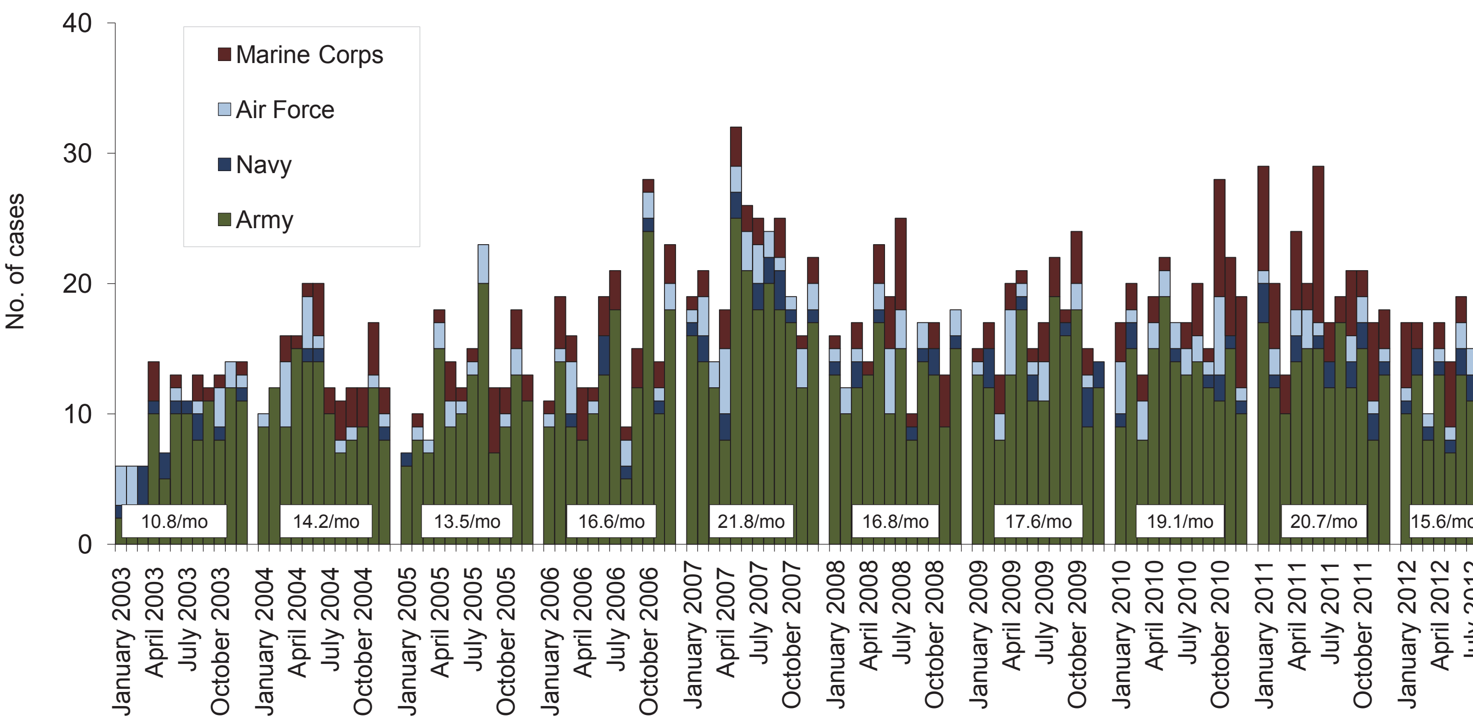
Traumatic brain injury (ICD-9: 310.2, 800-801, 803-804, 850-854, 907.0, 950.1-950.3, 959.01, V15.5_1-9, V15.5_A-F, V15.52_0-9, V15.52_A-F, V15.59_1-9, V15.59_A-F)[a]



Reference: Armed Forces Health Surveillance Center. Deriving case counts from medical encounter data: considerations when interpreting health surveillance reports. *MSMR*. Dec 2009; 16(12):2-8.

[a]Indicator diagnosis (one per individual) during a hospitalization or ambulatory visit while deployed to/within 30 days of returning from OEF/OIF. (Includes in-theater medical encounters from the Theater Medical Data Store [TMDS] and excludes 3,084 deployers who had at least one TBI-related medical encounter any time prior to OEF/OIF).

Deep vein thrombophlebitis/pulmonary embolus (ICD-9: 415.1, 451.1, 451.81, 451.83, 451.89, 453.2, 453.40 - 453.42 and 453.8)[b]

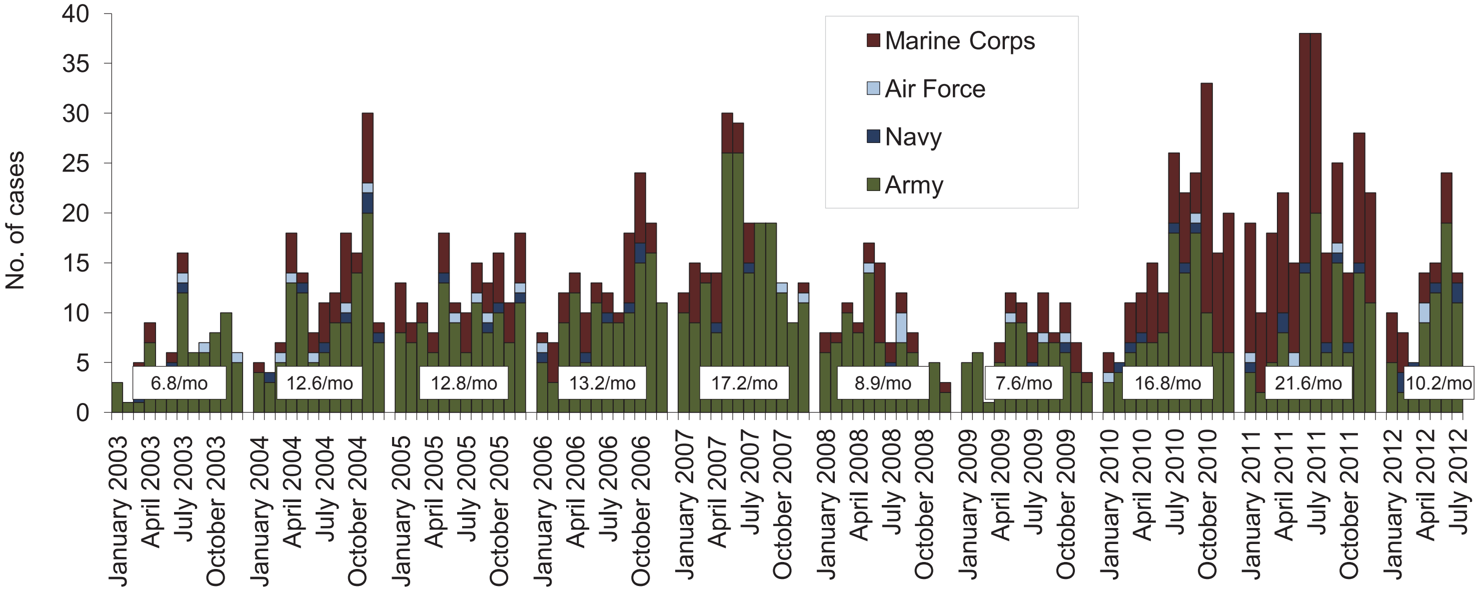


Reference: Isenbarger DW, Atwood JE, Scott PT, et al. Venous thromboembolism among United States soldiers deployed to Southwest Asia. *Thromb Res*. 2006;117(4):379-83.

[b]One diagnosis during a hospitalization or two or more ambulatory visits at least 7 days apart (one case per individual) while deployed to/within 90 days of returning from OEF/OIF.

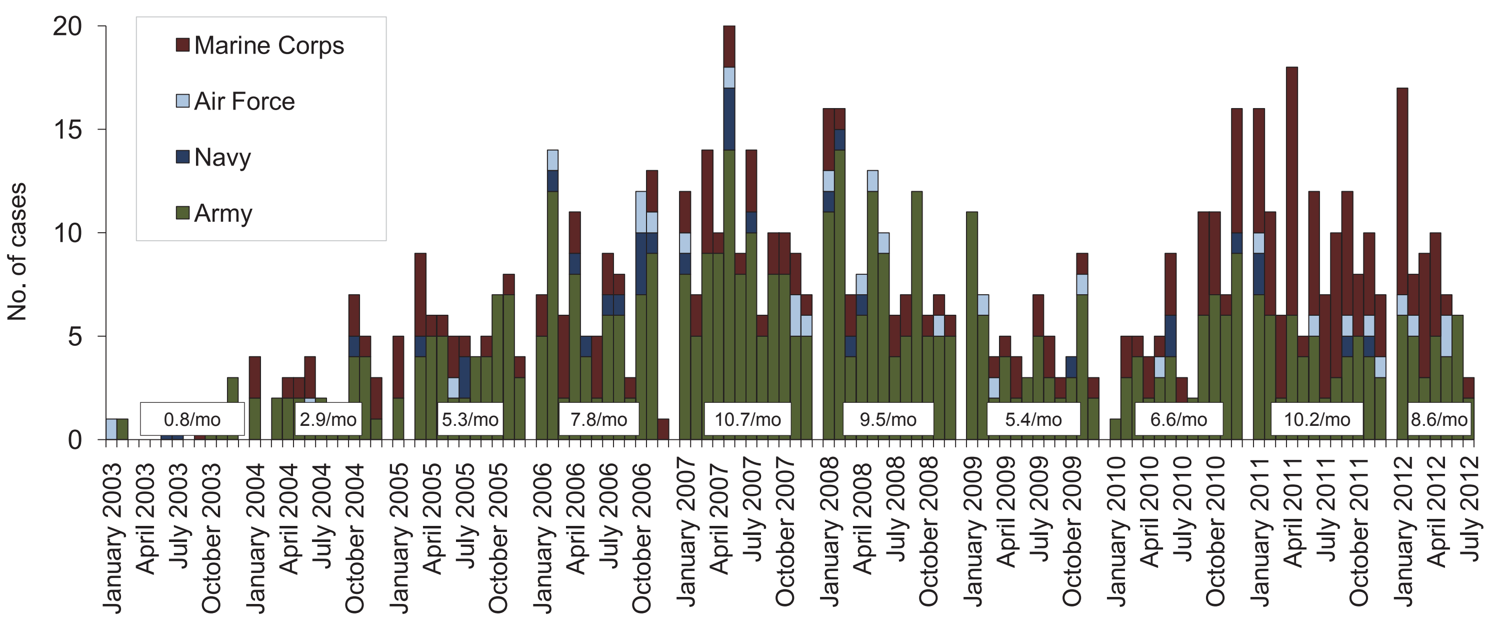
Deployment-related conditions of special surveillance interest, U.S. Armed Forces, by month and service, January 2003-July 2012 (data as of 26 August 2011)

Amputations (ICD-9-CM: 887, 896, 897, V49.6 except V49.61-V49.62, V49.7 except V49.71-V49.72, PR 84.0-PR 84.1, except PR 84.01-PR 84.02 and PR 84.11)[a]



Reference: Army Medical Surveillance Activity. Deployment-related condition of special surveillance interest: amputations. Amputations of lower and upper extremities, U.S. Armed Forces, 1990-2004. *MSMR*. Jan 2005;11(1):2-6.
[a]Indicator diagnosis (one per individual) during a hospitalization while deployed to/within 365 days of returning from OEF/OIF/OND.

Heterotopic ossification (ICD-9: 728.12, 728.13, 728.19)[b]



Reference: Army Medical Surveillance Activity. Heterotopic ossification, active components, U.S. Armed Forces, 2002-2007. *MSMR*. Aug 2007; 14(5):7-9.
[b]One diagnosis during a hospitalization or two or more ambulatory visits at least 7 days apart (one case per individual) while deployed to/within 365 days of returning from OEF/OIF/OND.

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