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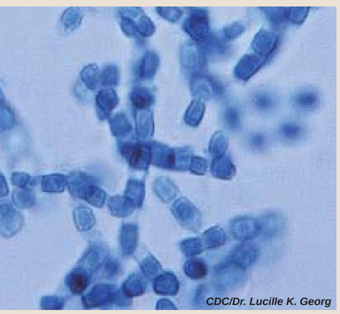
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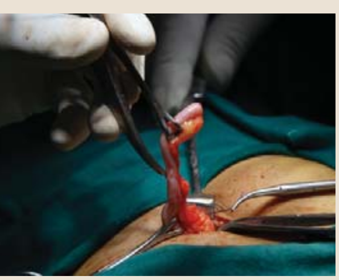

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Pulmonary and Extrapulmonary Coccidioidomycosis, Active Component, U.S. Armed Forces, 1999-2011

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Coccidioidomycosis is an infection caused by inhalation of *Coccidioides* species of fungi, which grow in the soil of the southwestern United States. Many thousands of military service members are assigned to, or perform training in, the endemic region. During the 13 years 1999 through 2011, 483 active component service members were diagnosed with coccidioidomycosis (rate: 2.69 cases per 100,000 person-years). Twelve percent of all diagnoses specified extrapulmonary infection, indicating dissemination to other organ systems (e.g., skin, skeleton, or central nervous system). Service members of Asian/Pacific Islander race had markedly higher incidence rates of coccidioidomycosis, particularly extrapulmonary disease, compared to members of other racial/ethnic groups. Crude incidence rates of coccidioidomycosis in service members older than 40 and males were higher than the rates of their respective counterparts. Preventive strategies to reduce exposure to this environmental pathogen are discussed.

Coccidioidomycosis (also known as "cocci") is a fungal infection caused by two nearly identical organisms, *Coccidioides immitis* and *Coccidioides posadasii*, that grow in the alkaline soil of certain geographic regions with low levels of annual rainfall and hot summers. Within the United States, the endemic region for the *Coccidioides* spp. extends from California through Nevada, Arizona and New Mexico into Texas. An estimated 350,000 military members are stationed in this coccidioidomycosis-endemic area and thousands more are sent there for training exercises.[1,2]

Studies suggest that approximately 60 percent of coccidioidomycosis infections are asymptomatic.[3,4] Most symptomatic infections affect the respiratory tract, and can vary in severity from subclinical or mild, self-limited respiratory infections to life-threatening pneumonia.[5] Less commonly, infection with *Coccidioides* can disseminate outside of the pulmonary system.[6] The most common sites of extrapulmonary dissemination are the skin,[7] osteoarticular system,[8] and central nervous system, particularly the meninges.[9,10] Severe cases can cause death.

A recent *MSMR* analysis evaluating trends in the incidence of coccidioidomycosis in active component service members demonstrated that the overall incidence rates have remained relatively stable in this population.[11] This analysis extends the previous analysis by examining rates, trends, and correlates of risk of pulmonary and extrapulmonary coccidioidomycosis in active component members.

METHODS

The surveillance period was 1 January 1999 to 31 December 2011. The surveillance population included all individuals who served in the active component of the U.S. Armed Forces at any time during the period. All data used to determine incident coccidioidomycosis diagnoses were derived from records routinely maintained in the Defense Medical Surveillance System (DMSS); these records document health care delivered to active component members during both hospitalizations and ambulatory (outpatient) visits in fixed U.S. military and civilian (contracted/reimbursed care) medical facilities.

For surveillance purposes, an incident case of coccidioidomycosis was defined as (a) a case reported as a notifiable medical event; or (b) one hospitalization; or (c) two or more outpatient encounters within 14 days of each other with diagnoses of "coccidioidomycosis" in the first diagnostic position (ICD-9-CM codes: 114.0-114.5 and 114.9).

For summary purposes, incident cases of coccidioidomycosis were grouped by ICD-9-CM codes into the following categories: "pulmonary" (codes: 114.0, 114.4, 114.5), "extrapulmonary" (codes: 114.1, 114.2, 114.3), and "unspecified" (code: 114.9). When individuals had diagnoses in more than one category, extrapulmonary cases took precedence over all other cases and pulmonary cases took precedence over unspecified ones. An individual could be counted as an incident case of coccidioidomycosis only once per lifetime. Prevalent cases (cases diagnosed prior to the beginning of the surveillance period) were excluded from analysis.

RESULTS

During the 13-year surveillance period, 483 active component members were diagnosed with coccidioidomycosis. Over the entire period, the crude rate of incident diagnoses of any coccidioidomycosis was 2.69 cases per 100,000 person-years (p-yrs). Of these incident cases, 154 (32%) were classified as pulmonary, 58 (12%) were extrapulmonary, and the remaining 271 cases were unspecified. One-fifth (n=96) of incident cases were hospitalized during the period **(Table 1)**. Crude incidence rates of diagnoses of extrapulmonary and pulmonary coccidioidomycosis fluctuated during the surveillance period but there were no clear trends **(Figure 1)**. In contrast, crude incidence rates of unspecified coccidioidomycosis increased sharply after 2004 and remained elevated through 2011.

TABLE 1. Incident cases and incidence rates of coccidioidomycosis, active component, U.S. Armed Forces, 1999-2011

	Pulmonary			Extrapulmonary			Total (including unspecified)			Hospitalizations[2]		
	No.	Rate[1]	IRR	No.	Rate[1]	IRR	No.	Rate[1]	IRR	No.	Rate[1]	IRR
Total	154	0.86		58	0.32		483	2.69		96	0.54	
Sex												
Male	140	0.91	1.00	53	0.35	1.00	427	2.79	1.00	83	0.54	1.00
Female	14	0.54	0.59	5	0.19	0.54	56	2.15	0.77	13	0.50	0.92
Race/ethnicity												
White, non-Hispanic	69	0.62	1.00	16	0.14	1.00	228	2.03	1.00	36	0.32	1.00
Black, non-Hispanic	32	1.00	1.61	23	0.72	5.14	111	3.48	1.71	26	0.82	2.56
Hispanic	18	1.00	1.61	4	0.22	1.57	61	3.38	1.67	15	0.83	2.59
Asian/Pacific Islander	24	3.37	5.44	10	1.40	10.00	51	7.16	3.53	13	1.82	5.69
Other/unknown	11	1.08	1.74	5	0.49	3.50	32	3.15	1.55	6	0.59	1.84
Age												
< 25	42	0.58	1.00	20	0.27	1.00	161	2.21	1.00	29	0.40	1.00
25-29	36	0.93	1.60	12	0.31	1.15	101	2.60	1.18	20	0.52	1.30
30-34	20	0.76	1.31	8	0.31	1.15	69	2.63	1.19	9	0.34	0.85
35-39	24	1.05	1.81	9	0.39	1.44	77	3.36	1.52	17	0.74	1.85
40+	32	1.73	2.98	9	0.49	1.81	75	4.06	1.84	21	1.14	2.85
Service												
Army	42	0.64	1.00	15	0.23	1.00	107	1.63	1.00	32	0.49	1.00
Navy	48	1.05	1.64	20	0.44	1.91	167	3.66	2.25	33	0.72	1.46
Air Force	51	1.16	1.81	21	0.48	2.09	164	3.71	2.27	22	0.50	1.02
Marine Corps	13	0.55	0.78	2	0.08	0.34	45	1.89	1.16	9	0.38	0.78

[1] Rate is per 100,000 person-years
[2] Hospitalizations are included in the numbers and rates of pulmonary, extrapulmonary and total coccidioidomycosis

Crude incidence rates of extrapulmonary coccidioidomycosis were higher among Asian/Pacific Islander and black, non-Hispanic military members (incidence rate ratios [IRR]: 10.00 and 5.14, respectively) as compared to their white counterparts. Asian/Pacific Islanders also had incidence rates of pulmonary coccidioidomycosis, total coccidioidomycosis and coccidioidomycosis hospitalizations that were more than twice those of any other racial/ethnic group **(Table 1)**.

Rates of total coccidioidomycosis by race-ethnicity demonstrated no clear trends, except among Asian/Pacific Islanders, whose increasing rates were the highest in nine of the 13 years in the period **(Figure 2)**. The rarity of the diagnosis resulted in wide fluctuations in annual rates in all racial/ethnic groups.

Older age was also a strong demographic correlate of risk; the highest incidence rates of any type of coccidioidomycosis were in service members 40 and

FIGURE 1. Incidence rates of coccidioidomycosis, active component, U.S. Armed Forces, 1999-2011

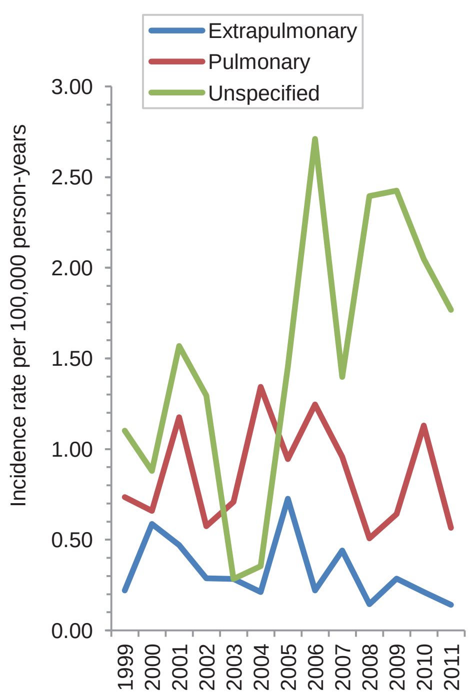
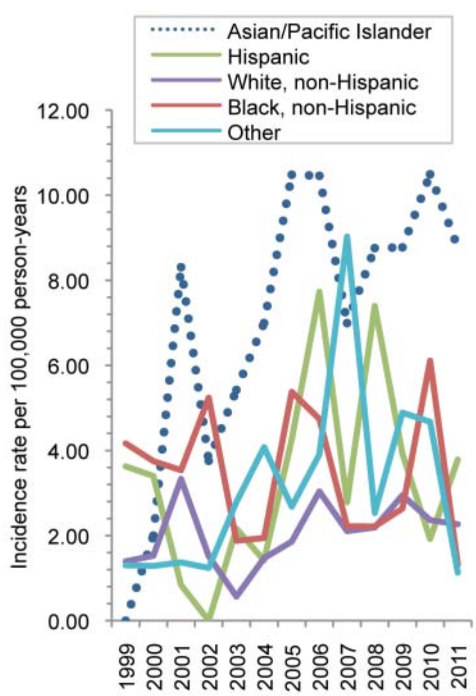


FIGURE 2. Incidence rates of coccidioidomycosis by race/ethnicity, active component, U.S. Armed Forces, 1999-2011



older. The risk of being hospitalized with coccidioidomycosis also increased with age; individuals 40 and older were almost three times more likely to be hospitalized than those younger than 25 **(Table 1)**.

Crude incidence rates of diagnoses of both pulmonary and extrapulmonary coccidioidomycosis were almost twice as high in males than females; however, this disparity was less dramatic for hospitalized cases (IRR, female: 0.92). Finally, there were higher coccidioidomycosis incidence rates among Air Force (IRR: 1.81) and Navy (IRR: 1.64) members relative to the Army.

EDITORIAL COMMENT

During the past 13 years, incidence rates of diagnosed coccidioidomycosis in active component members of the U.S. Armed Forces followed previously reported demographic patterns. For example, prior studies have documented that Asian/Pacific Islanders (especially Filipinos) and blacks have relatively high rates of coccidioidomycosis, particularly disseminated disease.[4,10] The results of the present analysis are consistent with these findings. Reasons for racial differences in coccidioidomyocosis incidence are not fully understood, although increased genetic susceptibility by some racial groups has been hypothesized.[12]

The crude incidence rate of coccidioidomycosis in this analysis was slightly higher in male than female service members. This has also been reported in other studies, and may be due to the stimulatory effect of certain human sex hormones on the growth of *C. immitis*.[13] At least part of the gender difference in rates may be explained by differences in occupational exposure between male and female service members.

Higher rates in members of the Air Force and Navy relative to other service members is likely attributable to the greater number of Air Force and Navy bases in the coccidioidomycosis-endemic region of the United States.

There are limitations to the analyses that should be considered when interpreting the results. For example, for this surveillance report, coccidioidomycosis cases were ascertained from ICD-9-CM coded diagnoses reported on standardized records of hospitalizations, ambulatory visits, and notifiable event reports. These ascertainment methods may underestimate the true number of coccidioidomycosis cases because they fail to capture misdiagnosed cases or cases that are asymptomatic and do not present for medical care.

The prevention of coccidioidomycosis among military members depends upon reducing exposure to the infective forms of *Coccidioides* spp. There are no feasible ways to eradicate the fungi from the soil, and it is impracticable to move all military bases and training sites outside of the endemic region. Available engineering controls to reduce exposures to *Coccidioides* spp. fungi include paving or oiling roads and planting groundcover such as grass. Vehicles such as tanks and personnel carriers that raise clouds of dust might be redesigned to reduce dust exposure to vehicle occupants. Personal protective equipment, such as masks, could be used to limit exposures due to high-risk training activities (e.g., maneuvers, drills), construction, or natural disruptions such as earthquakes or windstorms. Administrative controls might include policies to limit exposure to personnel during identified risk periods and to preclude the assignment or training of immunocompromised service members in the endemic area.

All of these preventive measures have been previously described and many of them have been recommended for decades. The lessons learned in the past should not be forgotten when troops are operating in an endemic area where the risk of exposure, albeit low, is foreseeable, and at least some practicable countermeasures can be implemented.

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Historical Perspective: Coccidioidomycosis in the U.S. Military and Military-associated Populations

Coccidioidomycosis, also known as "cocci" or "valley fever," has long been an occupational hazard for many U.S. military members. An infectious disease caused by inhalation of the spores of the fungi *Coccidioides immitis* or *Coccidioides posadasii*, coccidioidomycosis is endemic to the southwestern United States and Central and South America.[1,2] U.S. military members may be exposed to cocci when stationed in endemic areas; several large military bases are located in states where the disease is endemic (e.g., Arizona, California, Texas); exposure may also occur during training or field exercises in those regions.[3]

U.S. airmen low-crawl across field during combat tactics training at Vandenberg Air Force Base, CA

More than 100 years ago, the first human case of coccidioidomycosis was reported in an Argentinian soldier by Alejandro Posadas, an intern treating what he thought was a malignant skin disease. In the course of treating the soldier (who died of the disease in 1898), Posadas isolated the causative organism (which resembled the protozoan *Coccidia*) and successfully transmitted the infection to other mammals. In 1896, Rixford and Gilchrist reported two cases of "protozoan (coccidioidal) infection of the skin and other organs" in laborers in the San Joaquin Valley of California. Gilchrist, a pathologist, also concluded the organism was not a fungus but a protozoan; the two co-authors named the organism *Coccidioides immitis*. It was not until four years later that *C. immitis* was proven to be a fungus.[4]

In 1929, a medical student, Harold Chope, contracted the disease after accidentally inhaling *C. immitis* spores while working with old cultures in the laboratory of Ernest Dickson at Stanford University School of Medicine. Chope developed classic symptoms of pulmonary cocci (i.e., pleuritic chest pain, cough, pneumonia) and later developed erythema nodosum, an inflammatory disorder characterized by tender, red nodules under the skin. Chope recovered, and the event helped Dickson make the connection between *C. immitis* and the disease known at that time as San Joaquin Valley fever.[4]

Much of the seminal clinical and epidemiologic work in coccidioidomycosis was carried out by Dr. Charles E. Smith of the Stanford University School of Medicine. In 1937, Smith conducted a study of 432 individuals with cocci from Kern and Tulare counties in the San Joaquin Valley of California; this study helped to elucidate some fundamentals of disease transmission (via inhalation of spores) and the incubation period (between 1-3 weeks). Smith and colleagues also developed both the coccidioidin skin test and serologic testing for cocci. Notably, Smith found that high infection rates were likely in susceptible newcomers introduced to endemic areas; these findings were highly applicable to the thousands of troops being sent to California for training.[3,4]

Smith's results attracted the attention of the U.S. Army Air Forces, which began establishing training bases in the San Joaquin Valley in 1940-41. Concern over the potential impact of coccidioidomycosis on the health of troops working and training in the area prompted the Army to fund a study of cocci by Smith. Continued interest in the disease prompted the Army Epidemiologic Board, Preventive Medicine Division, to conduct epidemiologic studies and to evaluate mitigation strategies. These investigations led to a better understanding of asymptomatic disease rates, seasonal variation in infection rates (i.e., higher in late summer and early fall), and the increased risk of disseminated disease in certain racial and ethnic groups (e.g., Filipinos and African Americans). This work also prompted desert training initiatives to minimize the risk of infection, such as implementation of dust control measures (e.g., grassing and paving of airstrips).[5]

The Medical Statistics Division of the Army Surgeon General's Office estimated that 3,809 cases of coccidioidomycosis occurred among military personnel between 1942 and 1945, resulting in 39 deaths. Although the disease is usually diagnosed in endemic areas, some cocci cases presented for care in non-endemic areas because of the highly mobile nature of military troops. For example, among

77th Infantry Division soldiers who trained at Camp Hyder in Arizona from April to October 1943, cocci infections were subsequently reported from Indiantown Gap Military Reservation, Pennsylvania; Camp Pickett, Virginia; and the 219th General Hospital on Oahu. During WWII, the Army also contended with high infection rates among prisoners of war (POWs). Until 1944, Florence Station Hospital in Florence, Arizona, was used to house all POWs with tuberculosis. The high rate of primary pulmonary coccidioidomycosis among POWs with active tuberculosis prompted relocation of POWs with tuberculosis to other hospitals. Between June and August 1945, an outbreak of cocci in POWs at Camp Cooke, California resulted in hospitalization of about 10 percent of the POW population.[4,5]

The next military-associated outbreak reported in the medical literature was in 1977; after a dust storm at the Naval Air Station in Lemoore, California, 18 individuals stationed at the base were infected with cocci. Four individuals developed disseminated disease; of these, one African American male died.[6]

In 1992, an outbreak in a U.S. Marine reserve unit based in Tennessee was reported by Standaert and colleagues. Following a three-week training exercise at Vandenberg Air Force Base, California, several unit members sought treatment for symptoms consistent with cocci and one reservist was diagnosed with cocci during hospitalization for pneumonia. Eight of the 27 unit members later had positive serologic tests for cocci but only two members were diagnosed with cocci.[7]


Fort Irwin, CA National Training Center

In 2001, while training in Coalinga, California (in the San Joaquin Valley), six of 23 U.S. Navy SEALS presented with flu-like symptoms and were diagnosed with a viral illness. Six weeks later, one SEAL with persistent symptoms was diagnosed with cocci at a military hospital; subsequent serologic testing indicated that 10 of the men had had recent coccidioidomycosis infections. Notably, SEALs from Honolulu and San Diego were included in this training exercise; the three males stationed in Honolulu were all diagnosed with cocci after the nature of the outbreak was recognized. The 45 percent attack rate in this outbreak represents the highest reported in a military unit exposed during field exercises.[8]

The most recent military-associated outbreak reported in the literature involved a 12-man civilian construction crew excavating soil at Camp Roberts Military Base, California, in 2007; 10 men from the crew (83%) developed symptoms of pulmonary coccidioidomycosis.[9] During the same time period, a National Guard instructor at Camp Roberts was also diagnosed with cocci. His duties at Camp Roberts had included preparing terrain for training exercises as well as demonstrating maneuvers for trainees, such as crawling over long stretches of terrain without respiratory protection.[10]

A retrospective study of clinical diagnoses of coccidioidomycosis in military beneficiaries at Naval Air Station Lemoore, California, demonstrated that the incidence of coccidioidomycosis significantly increased between 2002 and 2006.[11] A recent *MSMR* analysis demonstrated a similar trend; during 2001 to 2012, cocci incidence rates among all active component members peaked in 2006 (at 0.41 per 100,000 person-years), but were relatively lower through 2012.[12]

The impact of coccidioidomycosis on the U.S. military and associated populations has been well documented and the disease remains a threat. Incidence rates in the civilian population have increased dramatically in the last decade. Concomitant increases in the military population can be expected given the significant numbers of personnel stationed or training in endemic areas, many of whom do not have immunity to the disease. As several of the outbreaks in this review illustrate, clinicians treating patients with respiratory symptoms outside of coccidioidomycosis endemic areas should be vigilant in obtaining a travel history and should consider the diagnosis of cocci if warranted.

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Appendicitis and Appendectomies, Active and Reserve Components, U.S. Armed Forces, 2002-2011

Appendicitis is common among young, healthy populations; appendectomy is one of the most common surgical procedures performed in the United States. Among active and reserve component members, there were 31,610 cases of appendicitis and 30,183 appendectomies during 2002 to 2011. The overall incidence rate of appendicitis in the active component was 18.4 per 10,000 person-years (p-yrs). During the period the incidence rates of appendicitis in the active component and counts in the reserve component increased. Active component males reported greater rates of perforated appendicitis (2.6 per 10,000 p-yrs). Active component females had higher rates of incidental appendectomies (2.6 per 10,000 p-yrs). During the period there was a four-fold increase in outpatient appendectomies, a decrease in nonincidental appendectomies without a diagnosis of appendicitis ("negative appendectomies"), and a decrease in inpatient bed days. The findings likely reflect more frequent uses of and advances in diagnostic imaging to detect and characterize appendicitis and a shift in surgical treatment to the outpatient setting with increasing use of laparoscopy for appendectomies.

The appendix is a small, blind-ended tube connected to the large intestine near its junction with the small intestine. Inflammation of the appendix, or appendicitis, can occur as a result of obstruction (i.e., by fecal material, a foreign object, or swelling of lymphoid tissue) or from infection; however, in most cases, the etiology is unknown. Appendicitis symptoms vary and may be difficult to diagnose, particularly among females who may be experiencing gynecological disease. Initially, appendicitis may cause mild, central abdominal pain that progresses into sharp, severe pain in the lower right quadrant of the abdomen. The pain is often accompanied by nausea, vomiting, diarrhea, and fever. Left untreated, an inflamed appendix can rupture, release bacteria contaminated material into the abdominal cavity, and produce peritonitis and sepsis. As such, appendicitis is a potentially life threatening condition that requires immediate medical intervention.

Treatment for appendicitis is prompt surgical removal of the appendix, a procedure known as appendectomy. Removal of an inflamed appendix before perforation or rupture decreases the probability of complications; therefore, appendectomies are commonly performed in individuals with presumed appendicitis. However, because other abdominal conditions may produce similar symptoms (e.g., ovarian cyst rupture, gastritis, diverticulitis) and the available diagnostic tests (computed tomography, ultrasound) are imperfect, approximately 15 percent of appendectomies yield normal appendices.[1,2]

Appendicitis is common in young, healthy populations, and appendectomy is one of the most common surgical procedures performed in the United States. Appendicitis occurs more commonly in individuals who are teenaged, male, and of white race; there is also some evidence of genetic predisposition and of possible seasonal variation in its occurrence.[3-5] In 2011, among active component service members, there were 2,420 hospitalizations due to acute appendicitis accounting for 5,906 hospital bed days.[6,7] The onset of appendicitis is unpredictable and often sudden; its occurrence in members of the U.S. Armed Forces can be particularly disruptive in deployed settings.

This report summarizes counts, rates (active component only), trends, and correlates of risk of appendicitis and appendectomies among active and reserve component service members. Medical evacuations for appendicitis among service members in recent theaters of combat operations (i.e., Iraq and Afghanistan) are also summarized.

METHODS

The surveillance period was 1 January 2002 to 31 December 2011. The surveillance population included all U.S. service members of the Army, Navy, Air Force, Marine Corps, and Coast Guard who served in an active or reserve component during the surveillance period. Cases were identified from

TABLE 1. Case-defining codes for appendicitis and appendectomy

ICD-9-CM diagnostic codes	
540.x	Acute appendicitis
540.0, 540.1	Perforated acute appendicits
540.9	Nonperforated acute appendicitis
541, 542	Non-acute appendicitis (e.g., chronic, recurrent)
543.x	Other/unspecified diseases of appendix (e.g., hyperplasia)
ICD-9-CM procedure codes (inpatient)	
47, 47.0, 47.01, 47.09	Nonincidental appendectomy
47.1, 47.11, 47.19	Incidental appendectomy
45.72, 45.73, 47.2, 47.92, 47.99	Other appendectomy-related
Current Procedural Terminology (CPT) codes (outpatient)	
44950, 44955, 44960	Open appendectomy
44970, 44979	Laparoscopic appendectomy
47600-47620, 44900, 44901	Other appendectomy-related

TABLE 2A. Counts and percentages of appendicitis and appendectomies by type, active and reserve components, U.S. Armed Forces, 2002-2011

Appendicitis		
	No.	% total
Total (active/reserve)	31,610	.
Acute appendicitis[a]	27,745	87.8
Perforated	4,531	14.3
Nonperforated	23,214	73.4
Non-acute appendicitis	3,297	10.4
Other appendicitis	568	1.8
Inpatient	27,263	86.2
Outpatient	4,347	13.8
Active component total	26,321	.
Acute appendicitis[a]	23,051	87.6
Perforated	3,618	13.7
Nonperforated	19,433	73.8
Non-acute appendicitis	2,833	10.8
Other appendicitis	437	1.7
Reserve component total	5,289	
Acute appendicitis[a]	4,694	88.8
Perforated	913	17.3
Nonperforated	3,781	71.5
Non-acute appendicitis	464	8.8
Other appendicitis	131	2.5
Appendectomies		
	No.	% total
Total (active/reserve)	30,183	.
Inpatient	24,703	81.8
Nonincidental	22,555	74.7
Incident	1,278	4.2
Other	870	2.9
Outpatient	5,480	18.2

[a] ICD-9 540 is not included in perforated or nonperforated categories and only appears in the total category

TABLE 2B. Counts and incidence rates of appendicitis by type and gender, active component, U.S. Armed Forces, 2002-2011

	Total		Males		Females	
Active component	No.	Rate[b]	No.	Rate[b]	No.	Rate[b]
Total	26,321	18.4	22,587	18.4	3,734	18.0
Acute appendicitis[a]	23,051	16.1	20,051	16.4	3,000	14.4
Perforated	3,618	2.5	3,240	2.6	378	1.8
Nonperforated	19,433	13.6	16,811	13.7	2,622	12.6
Non-acute appendicitis	2,833	2.0	2,253	1.8	580	2.8
Other appendicitis	437	0.3	283	0.2	154	0.7
Outpatient	3,045	2.1	.	.	.	.

[a] ICD-9 540 is not included in perforated or nonperforated categories and only appears in the total category
[b] Rate per 10,000 person-years

standardized records of hospitalizations and outpatient medical encounters during the surveillance period in fixed (i.e., not deployed, at sea) military and nonmilitary (purchased care) medical facilities.

An appendicitis case was defined as 1) a hospitalization with a case-defining appendicitis ICD-9 code in any diagnostic position or 2) an outpatient visit with a case-defining appendicitis ICD-9 code in the primary or secondary diagnostic position and an outpatient procedure code (Current Procedural Terminology [CPT]) indicative of appendectomy **(Table 1)**. For surveillance purposes, each affected individual was counted as an appendicitis case only once; service members who were identified as appendicitis cases prior to the start of the surveillance period were excluded from analysis.

Inpatient ICD-9 procedure codes and outpatient CPT codes enabled classification of appendectomies into inpatient and outpatient. Inpatient appendectomies were further classified as "nonincidental appendectomies" (i.e., appendectomies performed for the indicated purpose [appendicitis]), "incidental appendectomies" (i.e., appendectomies performed incidentally during intra-abdominal surgery), or "other appendectomy-related" **(Table 1)**. The numbers of appendectomies were summarized irrespective of whether the affected service members were diagnosed with appendicitis.

Incidence rates were calculated for active component members only. For reserve component members, complete administrative medical records and precise dates of active military service periods were unavailable.

Medical evacuations for appendicitis were estimated as appendicitis cases diagnosed from 5 days prior to 10 days after reported medical evacuations from the U.S. Central Command (CENTCOM) to locations other than CENTCOM.

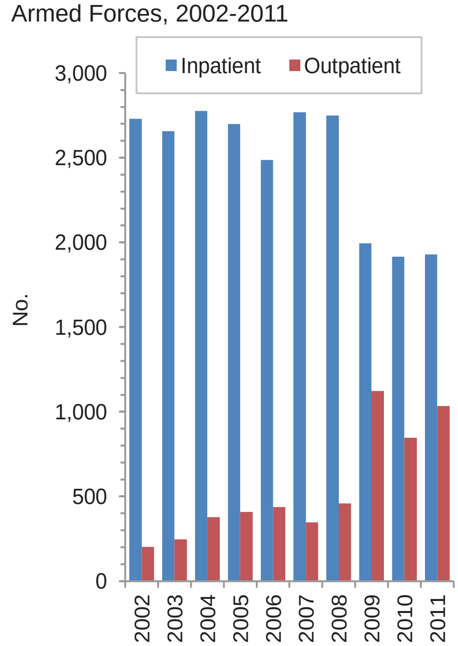
RESULTS

During the 10-year surveillance period there were 31,610 cases of appendicitis in active and reserve service members **(Table 2a)**. A majority of appendicitis cases were nonperforated acute appendicitis (n=23,214; 73.4%). Overall, 14.3 percent (n=4,531) had perforated acute appendicitis; 10.4 percent had non-acute appendicitis (n=3,297); and 1.8 percent (n=568) had other appendicitis. Nearly 14 percent (n=4,347) of all appendicitis cases were diagnosed in the outpatient setting **(Table 2a)**.

From 2002 to 2011 there were 30,183 appendectomies performed among active and reserve component members **(Table 2a, Figure 1)**. Of these, 74.7 percent were nonincidental inpatient appendectomies (n=22,555), 4.2 percent were incidental inpatient appendectomies (n=1,278), and 2.9 percent were inpatient other appendectomies (n=870).

Nearly one-fifth (n=5,480) of all appendectomies were outpatient procedures;

FIGURE 1. Number of appendectomies, active and reserve components, U.S. Armed Forces, 2002-2011



annual numbers of outpatient appendectomies increased by four-fold during the period **(Table 2a, Figure 1)**.

Active component

Among active component service members there were 26,321 cases of appendicitis **(Table 2b)**. Of these, a majority were acute appendicitis cases (n=23,051; 87.6%); the incidence rate of acute appendicitis was 16.1 per 10,000 person-years (p-yrs) **(Table 2b; Figure 2)**. The incidence rates of perforated (n=3,618) and nonperforated (n=19,433) acute appendicitis were 2.5 and 13.6 per 10,000 p-yrs, respectively. Non-acute appendicitis occurred in 2,833 cases (incidence rate: 2.0 per 10,000 p-yrs). There were 437 cases of other appendicitis (incidence rate: 0.3 per 10,000 p-yrs) **(Table 2b)**.

Over the 10-year period incidence rates of acute appendicitis increased by 21.3 percent (2002 to 2011 rate difference [RD]: +3.1 per 10,000 p-yrs) **(Figure 2)**. Rates of nonperforated acute appendicitis increased by 25.7 percent (RD: +3.2 per 10,000 p-yrs). Rates of perforated acute, non-acute, and other appendicitis remained relatively low and stable throughout the period **(Figure 2)**.

The overall appendicitis incidence rate was slightly higher among males than females (18.4 and 18.0 per 10,000 p-yrs, respectively) **(Table 2b)**. Also, the acute appendicitis incidence rate was 13.9 percent higher and the perforated appendicitis rate was 44.4 percent higher among males than females (acute and perforated appendicitis incidence rates: males, 16.4 and 2.6 per 10,000 p-yrs; females, 14.4 and 1.8 per 10,000 p-yrs). However, non-acute appendicitis and other appendicitis incidence rates were 55.5 percent and 250 percent, respectively, higher among females than males **(Table 2b)**.

Among racial/ethnic groups, rates of appendicitis overall were nearly twice as high among Hispanic and white, non-Hispanic (20.9 and 20.0 per 10,000 p-yrs, respectively) as black, non-Hispanic (11.7 per 10,000 p-yrs) service members **(Table 3)**. Overall rates of appendicitis were highest in the youngest age group (15-19 years) and decreased linearly with increasing age. Among the services, rates were highest in the Coast Guard (22.5 per 10,000 p-yrs) and lowest in the Navy (17.5 per 10,000 p-yrs) **(Table 3)**.

Appendicitis and appendectomies

Among active component members overall, most inpatient appendicitis cases had appendectomies "for standard indications" (i.e., nonincidental appendectomy) **(Table 4)**. However, females compared to males were more than twice as likely to have incidental appendectomies (0.21 and 0.09 per 10,000 p-yrs, respectively) and nearly five times more likely to have incidental appendectomies with no appendicitis-related diagnoses during the associated encounters (2.34 and 0.34 per 10,000 p-yrs, respectively).

FIGURE 2. Incidence rate of appendicitis by type, active component, U.S. Armed Forces, 2002-2011

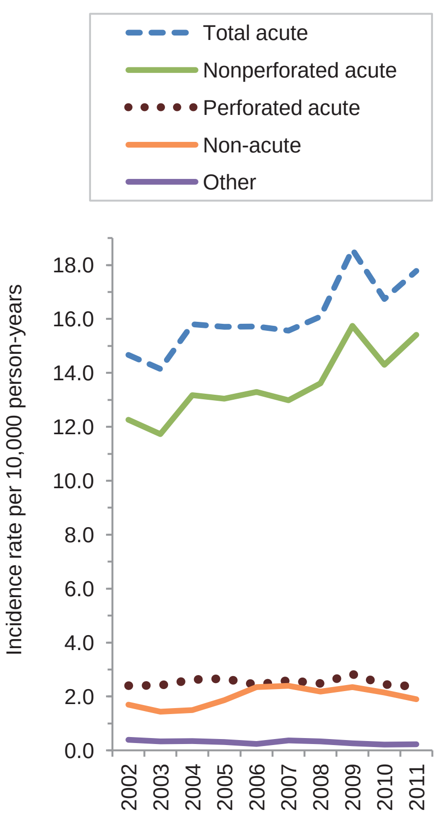


TABLE 3. Demographic and military characteristics of appendicitis, active and reserve components, U.S. Armed Forces, 2002-2011

	Active component		Reserve component	
	No.	Rate[a]	No.	% total
Total	26,321	18.4	5,289	.
Sex				
Male	22,587	18.4	4,475	84.6
Female	3,734	18.0	814	15.4
Race/ethnicity				
White, non-Hispanic	18,043	20.0	3,888	73.5
Black, non-Hispanic	2,836	11.7	506	9.6
Hispanic	3,126	20.9	558	10.6
Asian/Pacific Islander	770	13.6	130	2.5
American Indian/Alaskan Native	325	18.4	46	0.9
Other/Unknown	1,221	18.4	161	3.0
Age				
15-19	2,146	21.4	391	7.4
20-24	10,003	20.9	1,231	23.3
25-29	6,067	19.1	1,036	19.6
30-34	3,525	16.9	736	13.9
35-39	2,578	14.7	747	14.1
40-44	1,417	13.8	577	10.9
45+	584	11.7	571	10.8
Service				
Army	9,211	17.9	3,546	67.0
Navy	6,074	17.5	425	8.0
Air Force	6,516	18.9	1,002	18.9
Marine Corps	3,618	19.4	292	5.5
Coast Guard	902	22.5	24	0.5

[a]Rate per 10,000 person-years; for active component only

TABLE 4. Incidence rates (per 10,000 person-years) of appendicitis by gender, in relation to appendectomy, active component, U.S. Armed Forces, 2002-2011

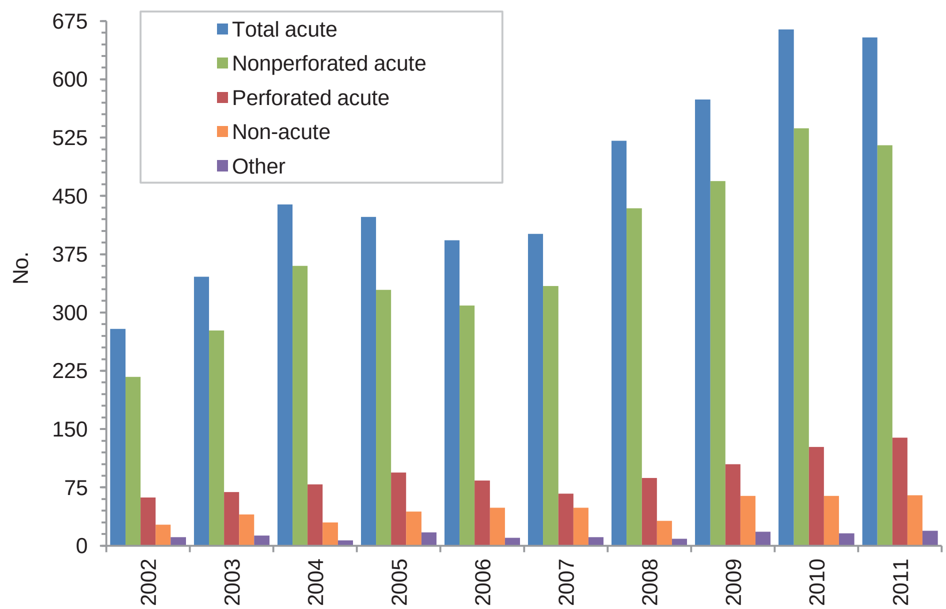
	Appendectomy procedure														
	Nonincidental inpatient			Incidental inpatient			Other inpatient			Outpatient			No appendectomy		
	Total	Males	Females	Total	Males	Females	Total	Males	Females	Total	Males	Females	Total	Males	Females
Total appendicitis	13.13	13.30	12.16	0.10	0.09	0.21	0.12	0.13	0.07	2.73	2.71	2.84	2.28	2.21	2.69
Acute	11.97	12.22	10.48	0.06	0.05	0.08	0.11	0.12	0.07	1.80	2.24	2.05	1.74	1.74	1.75
Non-acute	1.02	0.96	1.35	0.03	0.02	0.05	0.01	0.01	0.00	0.41	0.41	0.51	0.50	0.44	0.87
Other	0.15	0.12	0.32	0.02	0.01	0.07	0.00	0.00	0.00	0.09	0.06	0.27	0.04	0.04	0.08
No appendicitis-related diagnosis[a]	0.58	0.40	1.63	0.63	0.34	2.34	0.35	0.35	0.38	.	.	.	.	.	.
Total appendectomy	13.71	13.69	13.79	0.73	0.43	2.55	0.48	0.48	0.45	2.73	2.71	2.84	2.28	2.21	2.69

[a]No appendicitis-related diagnosis in the hospitalization with the procedure code of interest

Reserve component

In the reserve component, there were 5,289 cases of appendicitis (16.7% of all cases in service members) **(Table 2)**. A majority of cases were acute appendicitis (88.8%); 8.8 percent of cases were non-acute appendicitis; and 2.5 percent were other appendicitis. During the surveillance period, annual numbers of appendicitis cases among reserve component members increased by 132 percent (2002-2011:+796) **(Figure 3)**. Compared to their counterparts, the greatest proportions of appendicitis cases were reported among males (n=4,475; 84.6%); white, non-Hispanics (n=3,888; 73.5%); 20-24 year olds (n=1,231; 23.3%); and soldiers (n=3,546; 67.0%) **(data not shown)**.

FIGURE 3. Number of appendicitis cases by type, reserve component, U.S. Armed Forces, 2002-2011



Nonincidental appendectomies without a diagnosis of appendicitis

Of the 22,555 active and reserve component service members who underwent nonincidental appendectomies during hospitalizations, 4.3 percent (n=968) had no documented appendicitis-related diagnoses associated with the procedures (henceforth called "negative appendectomy"). During the period, the percentage of service members who had negative appendectomies decreased from 7.5 percent in 2002 to 2.1 percent in 2011 **(Figure 4)**.

Among female service members who had negative appendectomies (n=393), the primary diagnoses most commonly recorded were abdominal symptoms (n=150; 38.2%); of these, "right lower quadrant abdominal pain" was the most frequent specific diagnosis (n=123). Negative appendectomies were also relatively frequently associated with disorders of female pelvic organs (e.g., endometriosis, ovarian cyst) and pregnancy complications (n=129), diseases of the digestive system (n=42) and neoplasms (n=31) **(data not shown)**.

Among male service members who had negative appendectomies (n=575), abdominal symptoms (n=261, 45.4%) and diseases of the digestive system (n=151, 26.3%) were the most frequently reported primary diagnoses. Neoplasms were reported as primary diagnoses in 5.7 percent of such cases (n=33). Of note, "non-specific mesenteric lymphadenitis" accounted for 8.7 percent of all male cases (n=50) and 4.8 (n=19) of all female cases **(data not shown)**.

Bed days

Among active and reserve component members during the period overall, 27,263 service members were hospitalized for 57,026 days for evaluation and treatment of appendicitis (mean bed days per case: 2.3) **(data not shown)**. The mean durations of hospitalization varied in relation to the severity and urgency of the appendicitis-related condition, e.g., perforated acute appendicitis: 4.7 days; nonperforated acute appendicitis: 1.6 days; non-acute appendicitis: 1.8 days; and other appendicitis: 2.8 days **(data not shown)**.

During the period the total bed days per individual for acute appendicitis decreased by 0.6 days overall (22.2%), 0.8 days for perforated acute appendicitis (15.3%), and 0.3 days for nonperforated acute appendicitis (19.1%) **(Figure 5)**.

Medical evacuations

Of the 31,610 active and reserve component service members diagnosed with appendicitis , 225 were medically evacuated from Iraq/Afghanistan **(data not shown)**. Appendicitis was the recorded diagnosis on the medical evacuation records of 77.3 percent (n=174) of the medically evacuated cases. There were more than twice as many medical evacuations for appendicitis during the four years from 2004 to 2007 (65.8%; n=148) than from 2008 to 2011 (n=58) **(data not shown)**.

FIGURE 4. Percentage of nonincidental appendectomies with no appendicitis-related diagnosis ("negative appendectomy"), active and reserve components, U.S. Armed Forces, 2002-2011

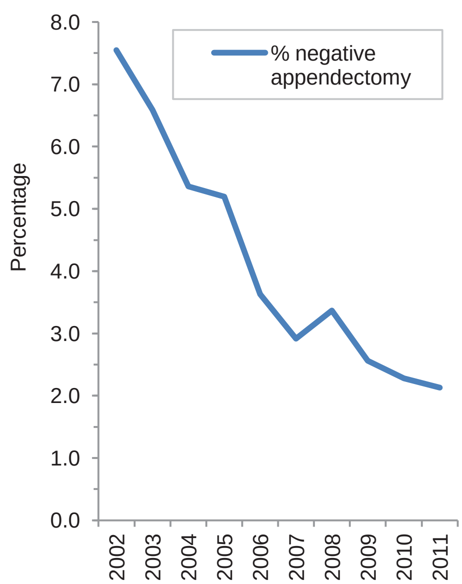
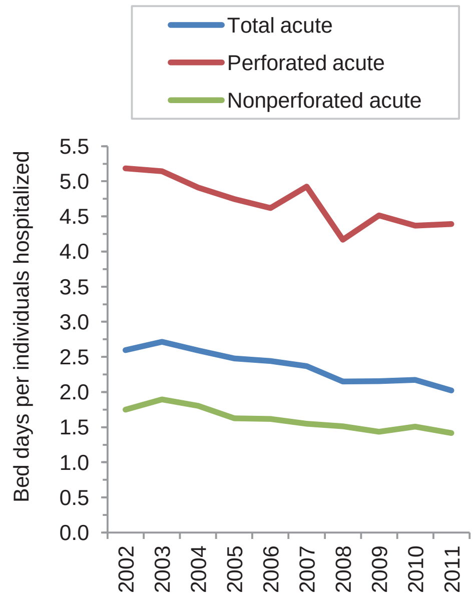


FIGURE 5. Bed days for acute appendicitis per individuals hospitalized, active and reserve components, U.S. Armed Forces, 2002-2011



EDITORIAL COMMENT

On average there were approximately 3,100 cases of appendicitis and 3,000 appendectomies in the active and reserve component every year from 2002 to 2010. Among active component service members, incidence rates of appendicitis increased throughout the period; also, among reserve component members, case counts of all appendicitis types increased. The causes of such increases among military members are unclear; and notably, there is scant epidemiologic research focused on characterizing determinants or recent trends of appendicitis in the U.S.

While incidence rates of appendicitis have increased among military members in recent years, the demographic groups with the highest rates (in the active component) and largest proportions (in the reserve component) of appendicitis cases were consistent with those reported previously by *MSMR*[8] and in the civilian population.[2-4] Demographic correlates of risk include male gender, Hispanic and white, non-Hispanic race/ethnicity, and younger age. This report also documented higher incidence rates of perforated acute appendicitis among male than female military members (rate ratio: 1.5); this observation has also been reported previously.[4]

Not surprisingly, a majority of appendicitis cases (73.4%) were nonperforated acute appendicitis. Overall, perforated appendix occurred in 16 percent of all service members with acute appendicitis. Compared to the proportion of perforations in similarly aged U.S. civilians with appendicitis (22% in 15-44 year olds), the proportion of perforated cases among affected military members was lower.[9] Increasing time between symptom onset and surgical treatment is associated with increasing risk of perforation.[10] Because health care is free to the individual and generally accessible to most military members, those with early signs and symptoms of appendicitis may be more likely than similarly affected civilians to seek medical care.

The increasing trend in outpatient appendectomies may reflect a shift in surgical treatment of emergent appendicitis to the outpatient setting. Same day discharge of patients undergoing laparoscopic appendectomy decreases the need for inpatient care and its associated costs, lowers risk of hospital acquired infections, and has little impact on rates of postoperative complications.[11,12] However, comparison of inpatient and outpatient appendectomy must be considered in light of several factors. Outpatient appendectomies reported here only indicate that the procedures were performed in outpatient settings; however, such appendectomies may have been associated with appendicitis-related hospitalizations. For example, a scheduled outpatient appendectomy may result in complications that require a hospital stay; also, a hospitalized individual may have an appendectomy performed in an outpatient clinic that is associated with the hospital.

In this analysis, the incidence rate of appendectomies was higher among female (19.6 per 10,000 p-yrs) than male (17.3 per 10,000 p-yrs) active component members; however, rates of overall appendicitis and nonincidental appendectomies were higher among males **(Table 4)**. As reported here and elsewhere,[3,8,13] females are more likely to have incidental appendectomies because, for example, the clinical manifestations of gynecologic diseases may be difficult to distinguish from those of appendicitis and the prophylactic removal of the appendix during gynecologic surgeries is often warranted.

The results presented here must be interpreted in light of a several limitations. For example, the analysis could not identify service members who had appendectomies prior to joining the U.S. Armed Forces; as such, these individuals were included in the population considered at risk of being affected by appendicitis or appendectomy. Because such individuals were not excluded from the denominators during rate calculations, the incidence rates reported here may underestimate the true incidence rates of the conditions of interest for this report.

Finally, the burden of appendicitis on the Military Health System will likely continue at current levels unless and until further studies into risk factors and etiology can inform steps to reduce the incidence. The shift towards outpatient treatment of appendicitis and the associated decrease in hospital bed days – without evidence of an increase in postoperative complications – has and will continue to decrease the financial and other associated burdens of appendicitis.

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Appendicitis and Appendectomies Among Non-service Member Beneficiaries of the Military Health System, 2002-2011

Among non-service member beneficiaries of the Military Health System, there were 79,820 cases of appendicitis and 98,385 appendectomies during 2002 to 2011; from the first to last year of the period, the annual number of appendicitis cases increased by 61.1 percent. Perforated acute appendicitis occurred in one quarter of all cases; the proportion of perforated cases was higher among males (30.2%) than females (23.3%). The annual number of total appendectomies decreased during the period; however, outpatient appendectomies increased 5-fold. The proportion of inpatient appendectomies that were incidental was greater in females (15.6%) than males (8.8%). During the period, the number of nonincidental appendectomies that were not associated with diagnoses of appendicitis ("negative appendectomies") decreased by 65 percent, and the mean number of inpatient bed days per appendicitis case decreased by 1 day (21.1%). The findings likely reflect more frequent uses of and advances in diagnostic imaging to detect and characterize appendicitis and a shift in surgical treatment to the outpatient setting with increasing usage of laparoscopy for appendectomies.

Non-service member beneficiaries of the U.S. Military Health System (MHS) include the family members and other dependents of current military members, military retirees, and other authorized government employees. In 2010, approximately 9.6 million individuals were eligible for medical care through the MHS; of these, 7.5 million were non-service member beneficiaries.[1] Non-service member beneficiaries differ from their actively serving counterparts in relation, for example, to age (children and retirees) and gender (much greater proportion of females) distributions; in addition, good health is a requirement for entry to military service but not for eligibility for care in the MHS.

This report summarizes counts, trends, and demographic correlates of risk of appendicitis and appendectomies among all non-service member beneficiaries of the MHS from 2002 through 2011.

METHODS

The surveillance period was 1 January 2002 to 31 December 2011. The surveillance population included all non-service member beneficiaries of the MHS ("beneficiaries"). An appendicitis case was defined as 1) a hospitalization with a case defining appendicitis ICD-9 code in any diagnostic position or 2) an outpatient visit with a case defining appendicitis ICD-9 code in the primary or secondary diagnostic position and an outpatient procedure code (Current Procedural Terminology [CPT]) indicative of appendectomy (case defining codes listed on page 7).[2] For surveillance purposes, each affected individual was counted as an appendicitis case only once; beneficiaries who were identified as appendicitis cases prior to the start of the surveillance period were excluded from the analysis.

Inpatient ICD-9 procedure codes and outpatient CPT codes enabled classification of appendectomies as inpatient and outpatient. Inpatient appendectomies were further classified as "nonincidental appendectomies" (i.e., appendectomies performed for the indicated purpose [appendicitis]), "incidental appendectomies" (i.e., appendectomies performed incidentally during intra-abdominal surgery), or "other appendectomy-related" (case-defining codes listed on page 7).[2] The numbers and natures of appendectomies were summarized without considering whether the affected beneficiaries were diagnosed with appendicitis.

TABLE 1. Counts of appendicitis diagnoses by demographic characteristics, non-service member beneficiaries, 2002-2011

	No.	%
Total	79,820	% total
Acute appendicitis	70,075	87.8
Perforated	21,015	26.3
Nonperforated	49,060	61.5
Non-acute	6,785	8.5
Other	2,960	3.7
Males total[a]	35,508	% males
Acute appendicitis	32,172	90.6
Perforated	10,723	30.2
Nonperforated	21,449	60.4
Non-acute	2,530	7.1
Other	806	2.3
Females total[a]	44,310	% females
Acute appendicitis	37,901	85.5
Perforated	10,291	23.2
Nonperforated	27,610	62.3
Non-acute	4,255	9.6
Other	2,154	4.9
Race/ethnicity[a]		% total
White, non-Hispanic	10,908	74.6
Black, non-Hispanic	1,643	11.2
Hispanic	1,297	8.9
Asian/Pacific Islander	749	5.1
American Indian/Alaskan Native	26	0.2
Other/Unknown	65,197	.
Age[a]		% total
0-9	5,952	7.5
10-19	19,957	25.0
20-29	11,915	14.9
30-39	6,363	8.0
40-49	8,255	10.4
50-59	8,588	10.8
60-69	9,396	11.8
70-79	6,674	8.4
80+	2,607	3.3

[a] Two unknown genders, 113 unknown ages, and 65,197 other/unknown race/ethnicities were excluded in % total calculations

RESULTS

Appendicitis

During the 10-year surveillance period there were 79,820 cases of appendicitis in beneficiaries **(Table 1)**. Over one-half of the appendicitis cases were diagnosed with nonperforated acute appendicitis (n=49,060; 61.5%). Approximately one quarter of all cases (n=21,015; 26.3%) had perforated acute appendicitis; 8.5 percent had non-acute appendicitis (n=6,785); and 3.7 percent (n=2,960) had other appendicitis **(Table 1)**. From the first to the last year of the period, the annual number of appendicitis cases increased by 61.1 percent (2002: n=6,036; 2011: n=9,723); nonperforated acute appendicitis cases accounted for the largest proportion (78.4%) of the increase in cases overall **(Figure 1)**.

Females (n=44,310) accounted for 55.5 percent of all cases and relatively more non-acute (9.6%) and "other" (4.9%) appendicitis diagnoses than males (7.1% and 2.3%, respectively). However, there were relatively more perforated acute appendicitis cases among males (30.2%) than females (23.3%). Approximately three fourths (74.6%) of all cases (whose race/ethnicities were documented) were white, non-Hispanic; and 40.0 percent of all affected beneficiaries were in their teens or twenties **(Table 1)**.

Appendectomies

From 2002 to 2011, there were 98,385 appendectomies performed among beneficiaries **(Table 2)**. A majority of appendectomies (76.9%) occurred in the inpatient setting. Of appendectomies performed in the inpatient setting, 60.1 percent were nonincidental appendectomies (n=45,462), 12.7 percent were incidental appendectomies (n=9,595), and 27.3 percent were "other" appendectomies (n=20,636).

Overall, more appendectomies were performed among females (n=55,946; 56.8%) than males (n=42,436; 43.1%) **(Table 2)**. Among females and males, there were similar proportions of inpatient (~77%) and outpatient appendectomies (~23%). However, relatively more inpatient appendectomies were reported as incidental among females (15.6%) than males (8.8%) **(Table 2)**.

From 2002 to 2011, annual numbers of documented appendectomies decreased by 33.1 percent. Of note, however, from 2008 to 2009, there was a sharp decrease in numbers of appendectomies overall but a sharp increase in appendectomies in outpatient settings **(Figure 2)**.

Nonincidental appendectomies without a diagnosis of appendicitis

Among the 45,462 beneficiaries who underwent inpatient nonincidental appendectomies, 8.6 percent (n=3,913) had no appendicitis-related diagnoses associated with the appendectomy procedures ("negative appendectomies"). Annual percentages of negative appendectomies decreased from 12.5 percent in 2002 to 4.4 percent in 2011 **(Figure 3)**.

Approximately one fourth (25.7%) of females who had negative appendectomies had primary diagnoses of neoplasms (n=744); the most frequently diagnosed

FIGURE 1. Number of appendicitis cases by type and year, non-service member beneficiaries, 2002-2011

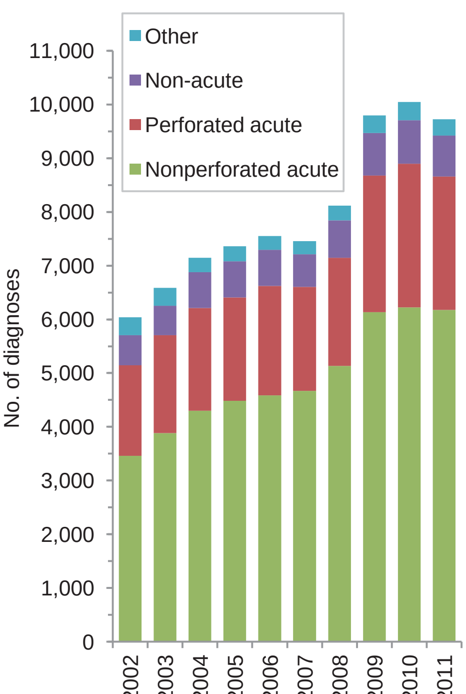


TABLE 2. Counts and percentages of appendectomies, non-service member beneficiaries, 2002-2011

	No.	% total
Total	98,385	.
Outpatient	22,692	23.1
Inpatient	75,693	76.9
Nonincidental	45,462	60.1
Incidental	9,595	12.7
Other	20,636	27.3
Males (total)	42,436	
Outpatient	9,848	23.2
Inpatient	32,588	76.8
Nonincidental	19,855	60.9
Incidental	2,865	8.8
Other	9,868	30.3
Females (total)	55,946	
Outpatient	12,841	23.0
Inpatient	43,105	77.0
Nonincidental	25,607	59.4
Incidental	6,730	15.6
Other	10,768	25.0

FIGURE 2. Inpatient appendectomies, by type, and outpatient appendectomies, non-service member beneficiaries, 2002-2011

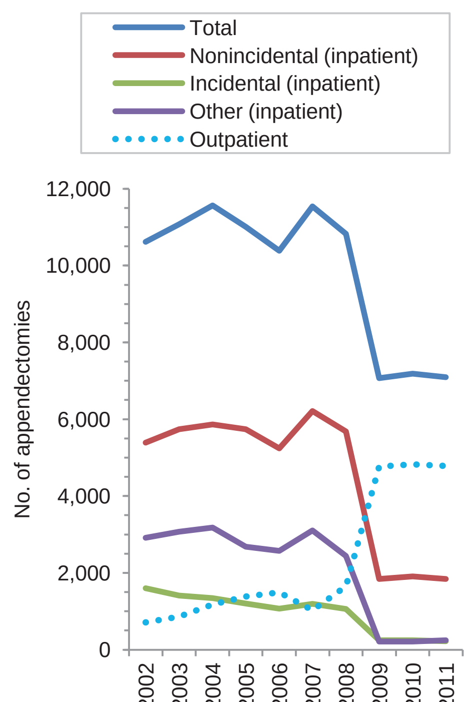


FIGURE 3. Percentage of nonincidental appendectomies with no appendicitis-related diagnosis ("negative appendectomy") by year, non-service member beneficiaries, 2002-2011

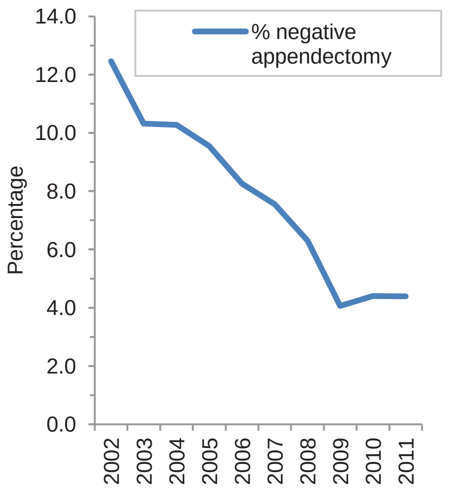
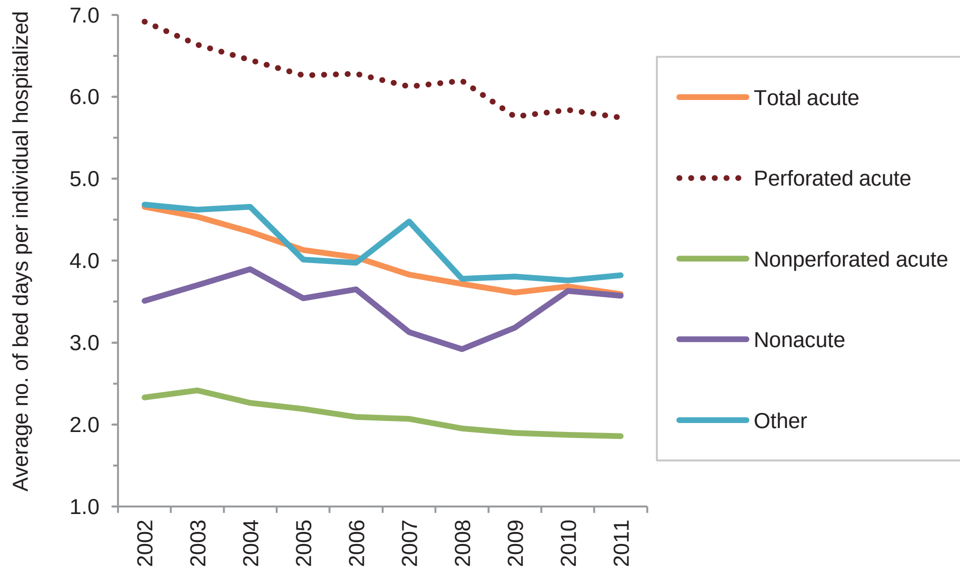


FIGURE 4. Average number of bed days for appendicitis per individual hospitalized by type of appendicitis, non-service member beneficiaries, 2002-2011



neoplasm was "malignant neoplasm of the ovary" (n=259; 8.9% total). Abdominal symptoms (n=645) accounted for 22.2 percent of negative appendectomies among females; "right, lower abdominal pain" (n=526) was the most frequent abdominal symptom-related diagnosis. Disorders of female genital organs (e.g., endometriosis, ovarian cyst) and pregnancy complications (n=624) and diseases of the digestive system (e.g., intestinal obstruction, diverticula) (n=477) accounted for 21.6 percent and 16.4 percent, respectively, of all negative appendectomies among females **(data not shown)**.

Nearly one-third (31.7%) of males who had negative appendectomies had primary diagnoses of diseases of the digestive system (n=316). Neoplasms (n=205) accounted for 20.5 percent of negative appendectomies among males; the most frequently diagnosed neoplasm was "malignant neoplasm of the colon" (n=55; 5.5%). Abdominal symptoms (n=193) were reported as primary diagnoses for 19.3 percent of negative appendectomies among males; "right, lower abdominal pain" (n=150) was the most frequently reported abdominal symptom-related diagnosis. Of note, "non-specific mesenteric lymphadenitis" was diagnosed in 6.8 percent (n=68) and 3.4 percent (n=99) of all male and female negative appendectomies, respectively **(data not shown)**.

Bed days

During the period overall, 60,831 beneficiaries were hospitalized for 240,543 days for evaluation and treatment of appendicitis (mean number of bed days per case: 4.0) **(data not shown)**. The mean durations of hospitalizations varied in relation to the severity and urgency of the appendicitis-related condition (e.g., perforated acute appendicitis: 6.2 days; nonperforated acute appendicitis: 2.1 days; non-acute appendicitis: 3.5 days; and other appendicitis: 4.2 days) **(data not shown)**.

From the beginning to the end of the period, annual mean numbers of bed days per affected individual decreased by 1.0 days for appendicitis overall (21.1% decrease), 1.2 days for perforated acute appendicitis (16.9% decrease), 0.5 days for nonperforated acute appendicitis (20.2% decrease), and 0.9 days for "other" appendicitis (18.4% decrease) **(Figure 4)**. Annual mean numbers of bed days per affected individual increased by 0.1 days for non-acute appendicitis (1.8% increase) **(Figure 4)**.

EDITORIAL COMMENT

On average there were approximately 8,000 cases of appendicitis and 9,800 appendectomies every year from 2002 to 2011 among non-service member beneficiaries of the Military Health System. Consistent with the appendicitis and appendectomy-related experience of members of the active and reserve components of the U.S. Armed Forces, the number of appendicitis—particularly nonperforated acute appendicitis—cases among beneficiaries increased throughout the ten-year period.[2]

In contrast to the experience of military members, there were relatively more perforated acute appendicitis cases among beneficiaries (26%) than active and reserve service members (16%). Of note, however, the proportion of perforated cases among beneficiaries was similar to that among late teen aged and adult civilians in the U.S. (28% in 15-64 year olds).[3] Also of note, in this report, there were relatively more perforated acute appendicitis cases among males than females; the finding is consistent with the experiences of active and reserve component members and with findings of other epidemiologic studies.[4,5,6]

Relatively high proportions of perforated cases among teenagers and young adults (10-19 years) with acute appendicitis also has been reported previously.[5,6]

During the period of interest for this report, the number of appendectomies of beneficiaries exceeded the number of appendicitis diagnoses among them. There are several likely explanations for this observation. Some nonincidental appendectomies were performed on persons who were found to not have appendicitis and thus did not receive appendicitis diagnoses. Also, some normal appendices were removed as prophylaxis in conjunction with surgery for other diseases (e.g., ovarian and colorectal cancer,[7,8] endometriosis[9]). Lastly, the "other" appendectomy category included appendectomies done as part of procedures such as cecectomy and hemicolectomy which were performed for indications other than appendicitis (e.g., colon cancer, Crohn's disease, cecal volvulus).

The sharp decrease in inpatient appendectomies between 2008 and 2009 may have occurred for several reasons. First, between 2008 and 2009, there was a sharp increase in reports of outpatient appendectomies among beneficiaries; the increase reflects a shift in the setting in which surgical treatment of appendicitis occurs. Second, the number of nonincidental appendectomies that yielded normal appendices decreased during the same period. Regardless of the reasons for the sudden change in the numbers and natures of appendectomies in 2009, it is clear that outpatient appendectomies were performed much more frequently after than before 2008.

The overall decrease in appendectomies without a diagnosis of appendicitis is consistent with the decrease observed in several recent studies.[10,11] The decrease may reflect increased usage of diagnostic imaging (computed tomography [CT], ultrasound) in patients suspected of having acute appendicitis as well as advances in diagnostic technology (i.e., improved image quality, single to multidetector CT).[11,12] Of the individuals who were not diagnosed with appendicitis but underwent nonincidental appendectomies, abdominal pain of the right lower quadrant was the most common single diagnosis in both men and women. Gynecological conditions involving the ovary (i.e., neoplasms and inflammatory and noninflammatory disorders of the ovary) were also relatively frequently reported among women who had appendectomies but were not diagnosed with appendicitis.

The average number of bed days per affected individual was higher among beneficiaries (4.0 days) than active and reserve component military members (2.3 days) – overall as well as for each type of appendicitis. Compared to service members, the beneficiary population includes both younger and older individuals who may have underlying other conditions that complicate treatment and recovery courses. Of note, however, during the period of interest for this report, the mean numbers of bed days per hospitalization markedly decreased among both beneficiaries as well as military members. This decrease is most likely from increased utilization of laparoscopy – which has become more common in uncomplicated appendicitis and is associated with shorter hospital stays and fewer surgical complications.[13,14]

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Seasonal Variation in Incident Diagnoses of Appendicitis among Beneficiaries of the Military Health System, 2002-2011

During the surveillance period there were 111,430 incident diagnoses of appendicitis in service members of the active and reserve component and all other beneficiaries of the Military Health System (e.g., family members, retirees). The average number of cases per month was higher in the summer (i.e., June to August) and lower in the late fall and winter months (i.e., November through February) **(Figures 1,2)**. Accounting for the varying numbers of days per month, the average numbers of cases per day was highest in June and lowest in December **(Figure 2)**. Despite the overall increase in appendicitis cases during the surveillance period, the seasonal variation was demonstrated each year **(Figure 3)**.

There are many studies reporting an increase in frequency of appendicitis cases during the summer months.[1-7] Several environmental and behavioral factors have been hypothesized to support these findings including: bacterial or viral pathogens and/or allergens occurring in warmer months, air pollution, relative humidity, altitude, changes in nutrition, and summer tourism.[1-7] However, no single causative factor has been consistently associated with seasonal variation of appendicitis. Development of appendicitis may be a multifactorial process involving biological and environmental factors.

FIGURE 1. Number of appendicitis cases by month, all beneficiaries of the Militiary Health System, 2002-2011

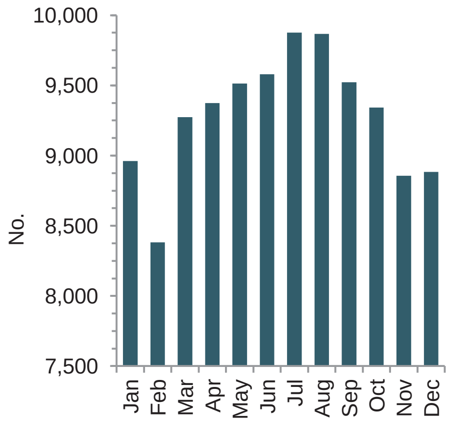

FIGURE 2. Average number of appendicitis cases per day, by month, all beneficiaries of the Military Health System, 2002-2011

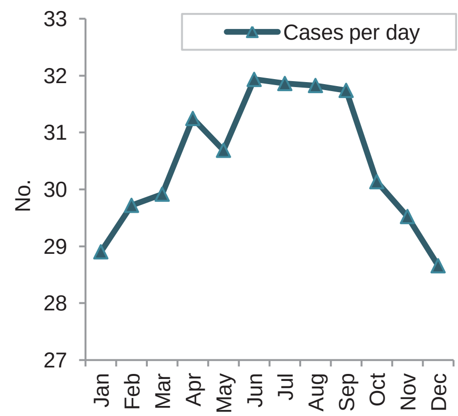

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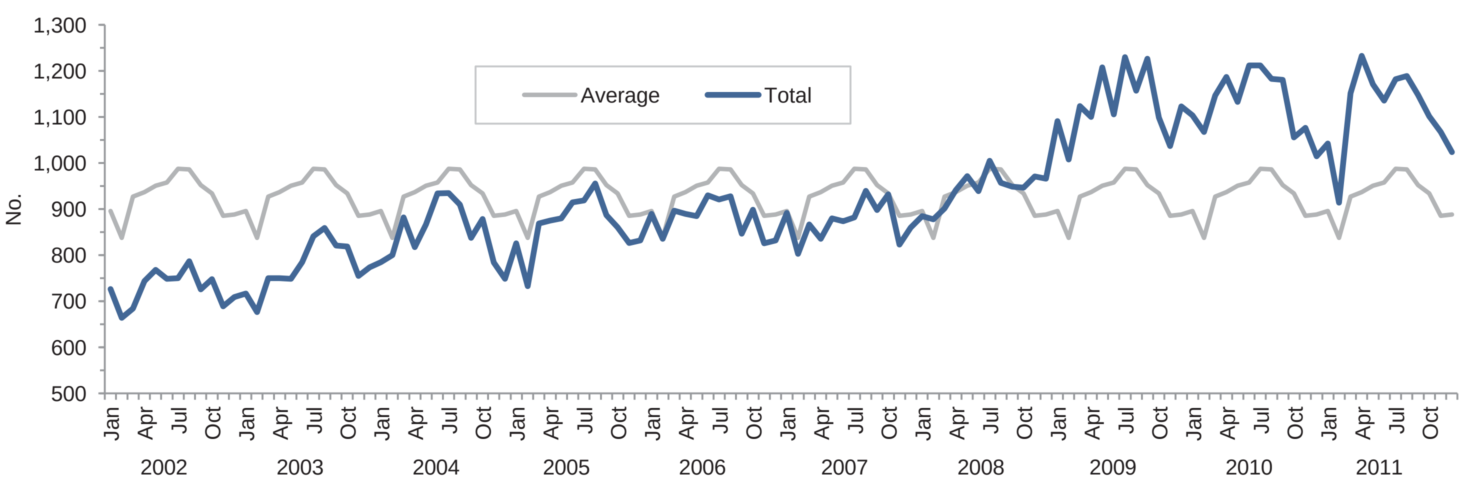
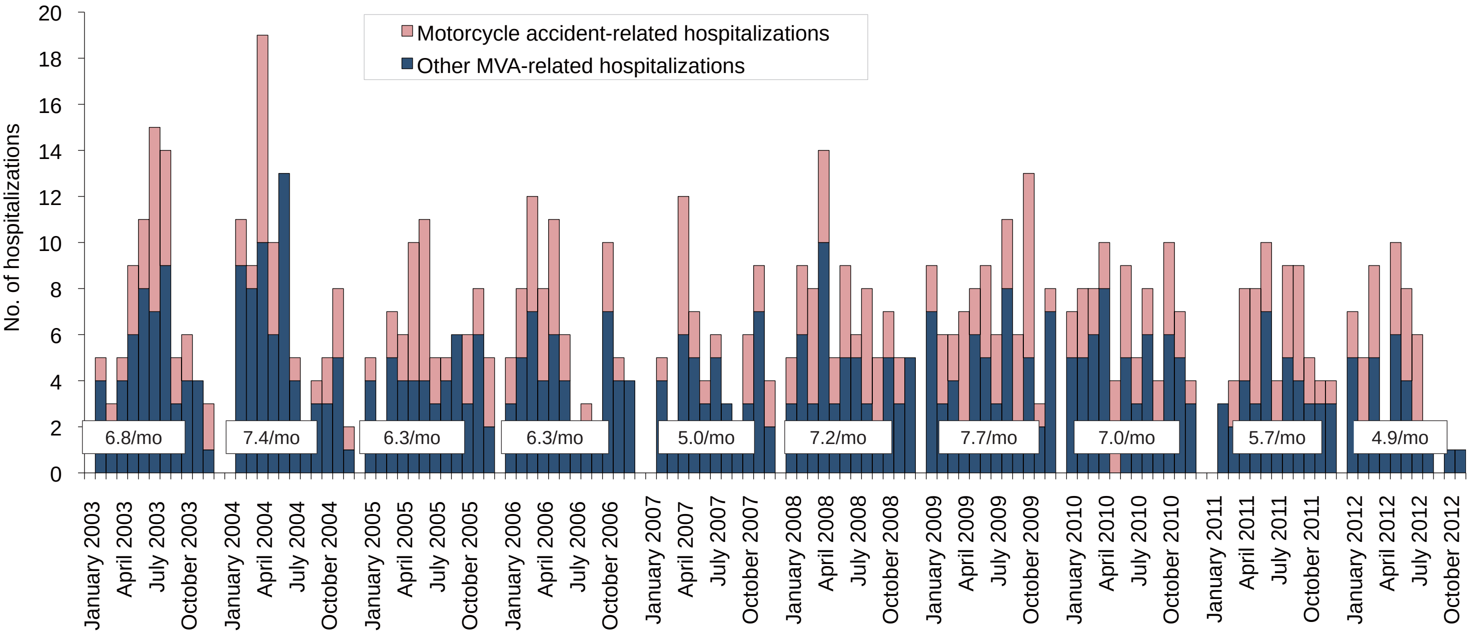
FIGURE 3. Number of appendicitis cases by month and year, all beneficiaries of the Military Health System, 2002-2011



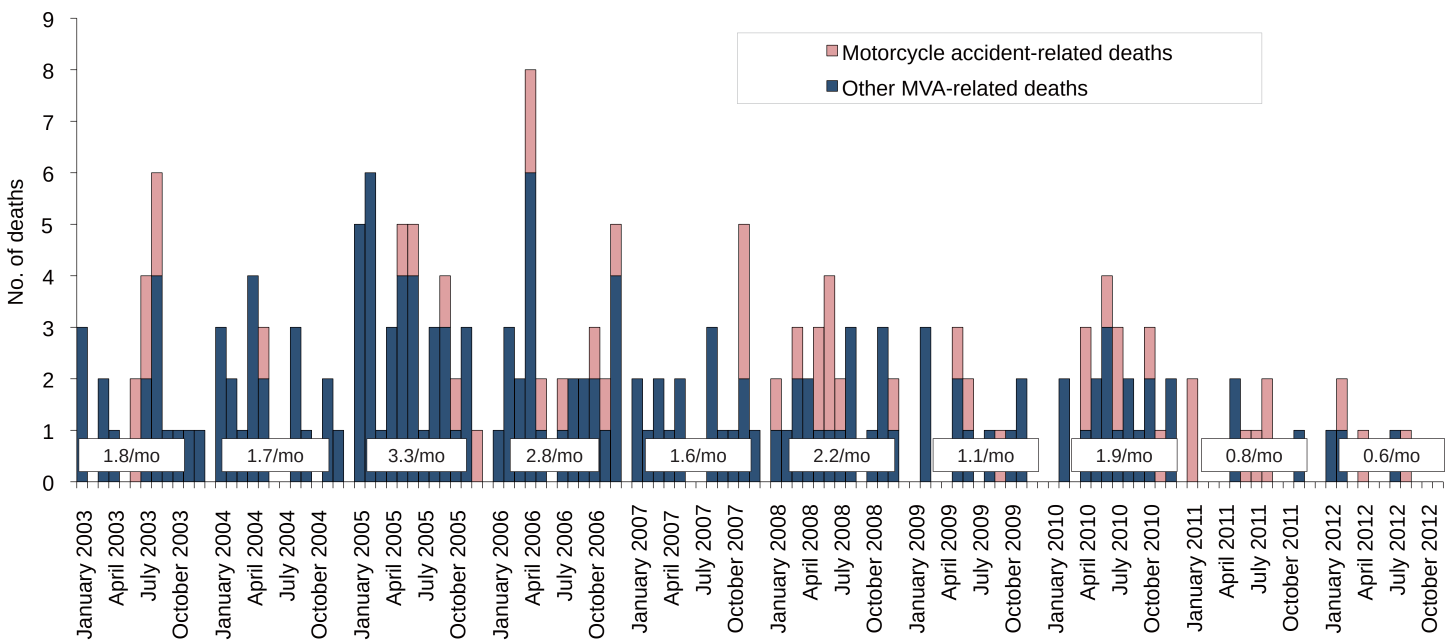
Deployment-Related Conditions of Special Surveillance Interest, U.S. Armed Forces, by Month and Service, January 2003-November 2012 (data as of 18 December 2012)

Hospitalizations outside of the operational theater for motor vehicle accidents occurring in non-military vehicles (ICD-9-CM: E810-E825; NATO Standard Agreement 2050 (STANAG): 100-106, 107-109, 120-126, 127-129)



Note: Hospitalization (one per individual) while deployed to/within 90 days of returning from OEF/OIF/OND. Excludes accidents involving military-owned/special use motor vehicles. Excludes individuals medically evacuated from CENTCOM and/or hospitalized in Landstuhl, Germany within 10 days of another motor vehicle accident-related hospitalization.

Deaths following motor vehicle accidents occurring in non-military vehicles and outside of the operational theater (per the DoD Medical Mortality Registry)



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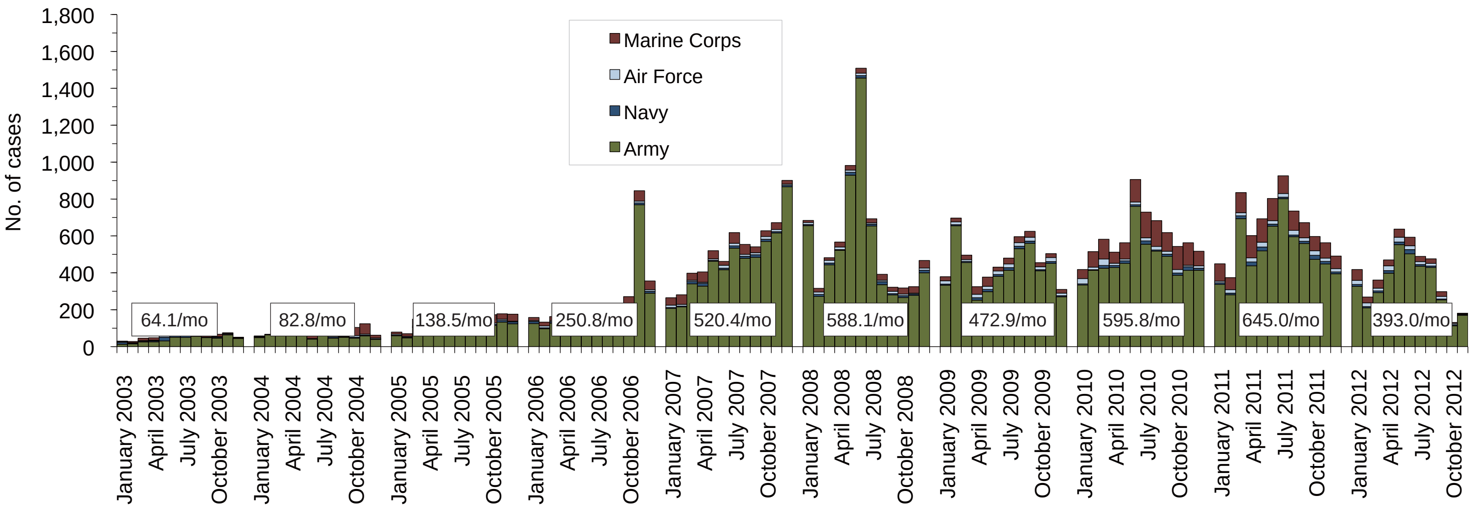
Note: Death while deployed to/within 90 days of returning from OEF/OIF/OND. Excludes accidents involving military-owned/special use motor vehicles. Excludes individuals medically evacuated from CENTCOM and/or hospitalized in Landstuhl, Germany within 10 days prior to death.

Deployment-Related Conditions of Special Surveillance Interest, U.S. Armed Forces, by Month and Service, January 2003-November 2012 (data as of 18 December 2012)

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]



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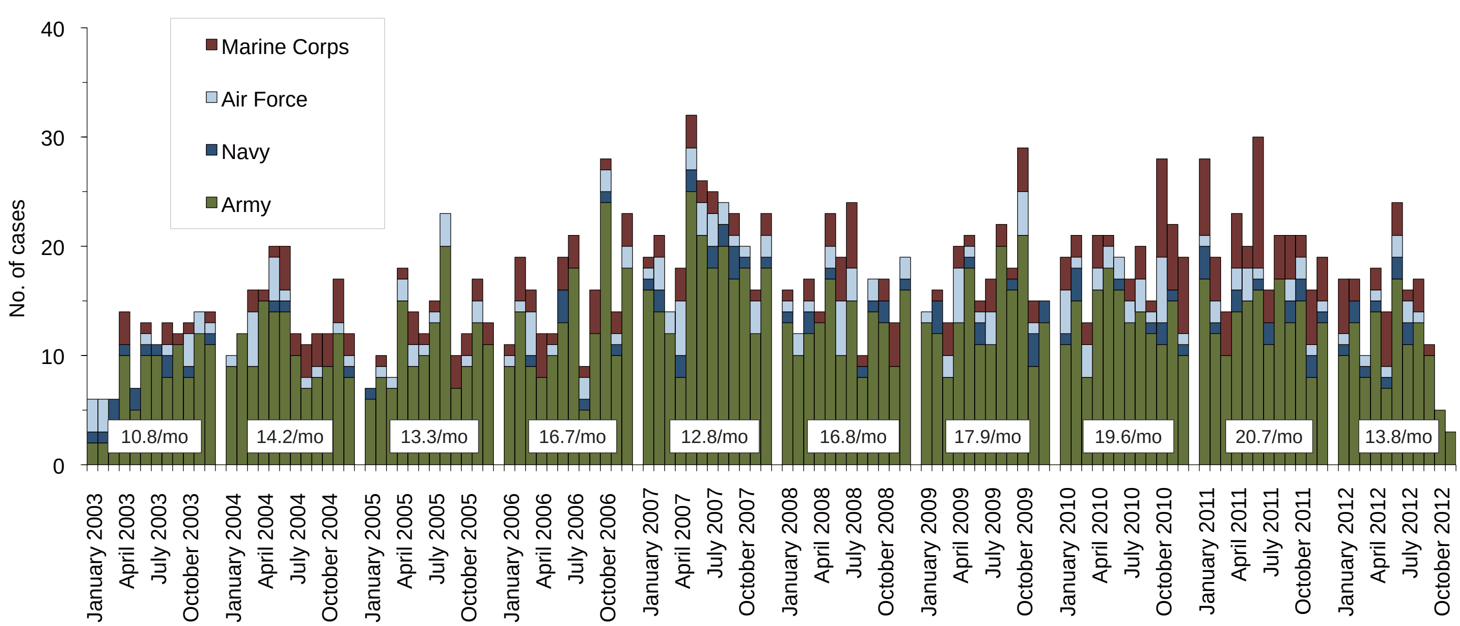
[a]Indicator diagnosis (one per individual) during a hospitalization or ambulatory visit while deployed to/within 30 days of returning from OEF/OIF. (Includes in-theater medical encounters from the Theater Medical Data Store [TMDS] and excludes 4,023 deployers who had at least one TBI-related medical 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.

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