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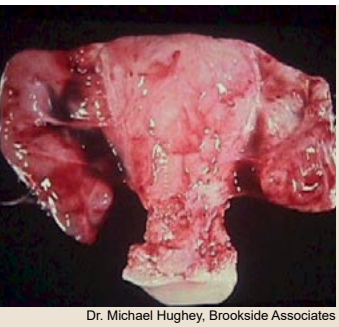

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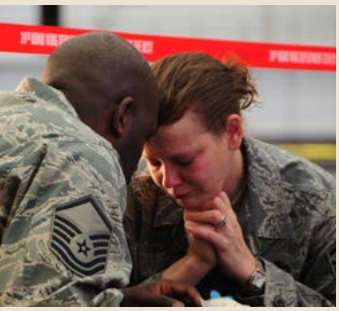


Incidence and Sequelae of Acute Pelvic Inflammatory Disease Among Active Component Females, U.S. Armed Forces, 1996–2016

Debra L. McKee, DO, (LCDR, USN); Zheng Hu, MS; Shauna Stahlman, PhD, MPH

Pelvic inflammatory disease (PID) is a consequence of untreated or inadequately treated sexually transmitted infections that can itself lead to infertility and ectopic pregnancy. Annual screening for asymptomatic chlamydia and gonorrhea infection helps reduce the incidence of acute PID. In the military, routine versus risk-based individual screening for chlamydia and gonorrhea began in some services in 2001, with full implementation across the services by 2005. From 1996 through 2016, rates of acute PID among active component women started to decline in the mid-2000s, consistent with national trends and coinciding with implementation of routine annual chlamydia and gonorrhea screening. Of active component women diagnosed with acute PID from 1996 through 2012, 6.1% were subsequently diagnosed with infertility or ectopic pregnancy, with higher proportions found among women in the Army and those aged 25–34 years. The overall decrease in the rates of acute PID in the military is consistent with national trends, and continued screening for asymptomatic chlamydia and gonorrhea infections should result in a continuing decline in the incidence of acute PID.

Pelvic inflammatory disease (PID) is an inflammatory condition of a woman's upper reproductive organs (uterus, fallopian tubes, and ovaries) caused by infection. It is estimated that more than 85% of PID is caused by microorganisms acquired via sexual transmission.[1] Although several different sexually transmitted pathogens have been implicated in the causation of PID, *Chlamydia trachomatis* (CT) and *Neisseria gonorrhoeae* (GC) in particular are the most important causes. It is estimated that up to 30% of women with CT infections[2,3] and up to 26% with GC infections have subclinical PID.[3] Untreated, PID can ultimately lead to infertility, ectopic pregnancy, and chronic pelvic pain.[1,4]

Because of the often asymptomatic presentation of CT and GC infections, routine screening of women for these sexually transmitted infections (STIs) is recommended by the U.S. Preventive Services Task Force and Centers for Disease Control and Prevention (CDC) to prevent conditions such as PID.[4,5] Annual screening for CT and GC infections can reduce the incidence of acute PID by up to 56%.[6,7] In 1999, the Armed Forces Epidemiological Board recommended that female military members receive screening at accession as well as during routine well-woman exams.[8] At the time of that recommendation, the Navy and Marine Corps began screening female recruits, and by 2005, the Air Force had implemented recruit screening.[8] To date, the Army does not screen female recruits on accession but does perform annual screening for all service women under age 25. Across all service branches, all female active component members under age 25 and those aged 25 years or older who are at increased risk are screened for CT and GC infection during scheduled well-woman exams.

Because acute PID is not reportable in the U.S., it is difficult to ascertain its true incidence and prevalence. The most recent report on National Disease and Therapeutic Index data stated that, from 2006 through 2015, the number of initial physician visits for acute PID decreased by approximately 36%, from 106,000 to 68,000.[9] In the U.S. military, from 2002 through 2011, the incidence of acute PID in active component women was eight cases per 1,000 person-years (p-yrs).[10] Consistent with national trends, the highest incidence was among those aged 17–24 years (10.5 cases per 1,000 p-yrs).[10] Among the services, the highest rate was seen in the Army (10.8 cases per 1,000 p-yrs).[10]

As previously mentioned, two outcomes of untreated acute PID can be infertility and ectopic pregnancy. In both of these instances, infection can lead to scarring and damage of female genitourinary organs, specifically the fallopian tubes, which in turn impedes proper fertilization and/or implantation during pregnancy.[1] For active component women during 2000–2012, the incidence rate of infertility due to tubal origin was 6.8 per 10,000 p-yrs.[11] Between 2002 and 2011, 0.64% of all active component pregnancies were diagnosed as ectopic. Of the service women with ectopic pregnancies, 11% had been given a previous diagnosis of PID, and another 11% had been previously diagnosed with CT or GC infections.[10]

The purpose of this study was to update previous *MSMR* analyses of the incidence of acute PID among U.S. active component women using a 21-year surveillance period from 1996 through 2016. A secondary objective was to report on the proportion of service women with previously diagnosed PID who were subsequently diagnosed with infertility or ectopic pregnancy.

METHODS

The surveillance period to assess incidence rates for acute PID was 1 January 1996 through 31 December 2016. However, only women who were diagnosed with acute PID during 1 January 1996 through 31 December 2012 and who remained in the active component for at least 4 years following incident acute PID diagnosis were followed for diagnoses of infertility or ectopic pregnancy. The surveillance population was all female active component service members of the U.S. Army, Navy, Air Force, or Marine Corps serving at any time during the surveillance period. The data for this study were derived from records routinely provided to the Armed Forces Health Surveillance Branch (AFHSB) and maintained in the Defense Medical Surveillance System (DMSS).

Overall and annual incidence rates of acute PID were examined by age group, race/ethnicity, service branch, rank, and marital status. Other considerations were whether or not service women had received a previous diagnosis of CT or GC infection, and also whether they had received just one or two or more diagnoses of CT/GC. An incident case of CT or GC was defined by the presence of a single outpatient medical encounter with a qualifying ICD-9 or ICD-10 code in the 1st or 2nd diagnostic position, or by one reportable medical event for chlamydia **(Table 1)** or gonorrhea **(Table 2)**. To qualify for a determination of a repeat infection of CT/GC, at least 30 days must have passed since the last medical encounter for the previous CT/GC diagnosis.

The diagnosis of acute PID was based on the AFHSB acute PID case definition,[12] which specifies one hospitalization or medical encounter using an appropriate ICD-9/ICD-10 code **(Table 3)**, excludes cases of pregnancy-related PID, and states that an individual can only be counted once per lifetime. Women who had a previous diagnosis of acute PID or a previously listed procedure code or diagnosis of hysterectomy were excluded. Theater Medical Data Store (TMDS) data were not used, so deployed person-time was excluded in the calculation of incidence rates for acute PID.

TABLE 1. ICD-9/ICD-10 diagnostic codes for chlamydia

Description	ICD-9	ICD-10
Chlamydial infection of lower genitourinary tract	099.41	A56.0
Chlamydial infection of lower genitourinary tract, unspecified	099.53	A56.00
Chlamydial cystitis and urethritis	099.50	A56.01
Chlamydial vulvovaginitis	099.55	A56.02
Other chlamydial infection of lower genitourinary tract	–	A56.09
Chlamydial infection of genitourinary tract, unspecified	–	A56.2

First-ever cases of infertility and ectopic pregnancy were measured within 4 years after an incident acute PID diagnosis. To be counted as a case of infertility, an individual must have had two outpatient encounters with corresponding ICD-9 (628.*) or ICD-10 code (N97.*) listed in the first or second diagnostic position, or a case-defining diagnosis in the first diagnostic position of one inpatient encounter. To be counted as a case of ectopic pregnancy, an individual must have had an ICD-9 (633.*, 761.4) or ICD-10 code (O00.*) in any diagnostic position, and at least one inpatient or outpatient ICD-9 or ICD-10 procedural code **(Table 4)** in the same encounter.

RESULTS

During 1996–2016, there were 22,992 cases of acute PID, with a crude overall incidence rate of 6.0 cases per 1,000 p-yrs **(Table 5)**. The highest crude annual rate occurred in 2001 at 8.0 cases per 1,000 p-yrs, after which there was a steady decline to the lowest rate of 4.5 cases per 1,000 p-yrs in 2014. In 2015 and 2016, there were slight increases, with the crude annual rate of PID in 2016 reaching 5.3 cases per 1,000 p-yrs **(Figure 1)**.

TABLE 2. ICD-9/ICD-10 diagnostic codes for gonorrhea

Description	ICD-9	ICD-10
Gonococcal infection of lower genitourinary tract without periurethral or accessory gland abscess	098.0	A54.0
Gonococcal infection of lower genitourinary tract, unspecified	098.2	A54.00
Gonococcal cystitis and urethritis, unspecified	–	A54.01
Gonococcal vulvovaginitis, unspecified	–	A54.02
Gonococcal cervicitis, unspecified	–	A54.03
Other gonococcal infection of lower genitourinary tract	–	A54.09
Gonococcal infection of lower genitourinary tract with periurethral or accessory gland abscess	–	A54.1
Gonococcal infection, unspecified	–	A54.9

Overall incidence rates of acute PID were highest among women aged 24 years or younger, non-Hispanic black service women, those in the Army, and those who had any previous diagnosis of CT or GC **(Table 5)**. Annual rates of PID in the youngest age group showed the greatest fluctuation during the surveillance period. The overall rate among service women in this age group peaked in 2001 at 11.9 cases per 1,000 p-yrs and reached a low of 6.6 cases per 1,000 p-yrs in 2014 **(Figure 2)**. Throughout the surveillance period, annual incidence rates for PID remained consistently higher among service women in the youngest age group, followed by those aged 25–34 years and those aged 35 years or older.

Throughout the surveillance period, annual rates of acute PID were higher among service women in the Army and Marine Corps than among women in the other services **(Figure 3)**. Women in the Army had the highest rates overall until 2010 when the rates among women in the Marine Corps (10.1 per 1,000 p-yrs)

TABLE 3. ICD-9/ICD-10 diagnostic codes for acute pelvic inflammatory disease

Description	ICD-9	ICD-10
Acute gonococcal infections of the upper genitourinary tract	098.10, 098.16, 098.17, 098.19	A54.21, A54.24, A54.29
Gonococcal peritonitis	098.86	A54.85
Chlamydia trachomatis infection of the peritoneum and other genitourinary organs	614.9, 099.56	A56.1, A56.11, A56.8
Acute or unspecified inflammatory disease of pelvice organs and tissues	614.0, 614.2	N70.0, N70.01, N70.02, N70.03, N70.9, N70.91, N70.92, N70.93
Acute or unspecified inflammatory disease of the uterus	615.0, 615.9	N71.0, N71.9
Other female pelvic inflammatory diseases	614.3, 614.5, 614.8	N73.0, N7.3, N73.5, N73.8, N73.9

overtook Army rates (9.1 per 1,000 p-yrs). After 2010, rates among women in the Army and Marine Corps declined to their lowest points in 2013 (5.8 per 1,000 p-yrs) and 2014 (5.3 per 1,000 p-yrs), respectively. Rates among women in the Navy remained relatively unchanged throughout the surveillance period. There was a peak at 7.5 per 1,000 p-yrs in 2000 among women in the Air Force, after which there was a steady decline during the rest of the period with the lowest rate of 2.9 per 1,000 p-yrs occurring in 2014.

When overall incidence rates were stratified based on previous CT or GC diagnosis, women who had a previous diagnosis

TABLE 4. Diagnostic and procedural codes for ectopic pregnancy

Diagnostic codes (ICD-9)	Diagnostic codes (ICD-10)	Description
633.*, 761.4	O00.*	Ectopic pregnancy
Inpatient procedure codes (ICD-9)	Inpatient procedure codes (ICD-10)	
65.01, 65.09, 65.31, 65.39	0U9040Z, 0U904ZZ, 0U9140Z, 0U914ZZ, 0U9240Z, 0U924ZZ, 0U9000Z, 0U9100Z, 0U910ZZ, 0U9200Z, 0U920ZZ, 0UT04ZZ, 0UT14ZZ, 0UT04ZZ, 0UT14ZZ, 0UT00ZZ	Oophorotomy, oophorectomy
65.41, 65.49	0UT54ZZ, 0UT64ZZ	Salpingo-oophorectomy
66.01, 66.02	0U950ZZ, 0U960ZZ, 0U970ZZ, 0UC50ZZ, 0UC53ZZ, 0UC54ZZ, 0UC57ZZ, 0UC58ZZ, 0UC60ZZ, 0UC63ZZ, 0UC64ZZ, 0UC67ZZ, 0UC68ZZ, 0UC70ZZ, 0UC73ZZ, 0UC74ZZ, 0UC77ZZ, 0UC78ZZ, 0U9500Z, 0U9540Z, 0U9570Z, 0U9580Z, 0U9600Z, 0U9640Z, 0U9670Z, 0U9680Z, 0U9700Z, 0U9740Z, 0U9770Z, 0U9780Z, 10D27ZZ, 10D28ZZ, 10T27ZZ, 10T28ZZ	Salpingotomy, salpingostomy
66.51, 66.62, 66.69, 66.4	0UT50ZZ, 0UT10ZZ, 0UT60ZZ, 0UT70ZZ, 0UT74ZZ, 0UT77ZZ, 0UT78ZZ, 0UT7FZZ, 0UB50ZZ, 0UB53ZZ, 0UB54ZZ, 0UB57ZZ, 0UB58ZZ, 0UB60ZZ, 0UB63ZZ, 0UB64ZZ, 0UB67ZZ, 0UB68ZZ	Salpingectomy
69.52, 66.91, 69.02	0U9530Z, 0U953ZZ, 0U957ZZ, 0U958ZZ, 0U9630Z, 0U963ZZ, 0U967ZZ, 0U968ZZ, 0U9730Z, 0U973ZZ, 0U977ZZ, 0U978ZZ, 10D17ZZ, 10D18ZZ	Aspiration, curettage
74.3	10T20ZZ, 10T23ZZ, 10T24ZZ	Ectopic pregnancy removal
99.25	3E03305, 3E04305, XW03351, XW04351	Methotrexate injection
Outpatient procedural codes (CPT)		
49320		Diagnostic laparoscopy
58661, 58700, 59120, 59151		Oophorectomy and/or salpingectomy
58673, 58770		Salpingostomy (salpingoneostomy)
58679		Laparoscopy, oviduct, ovary
58720		Salpingo-oophorectomy
59121, 59130, 59135, 59136, 59140, 59150		Other surgical or laparoscopic treatment of ectopic pregnancy
90782, 96401, J9250, J9260		Methotrexate injection

TABLE 5. Incident cases and incidence rates of acute pelvic inflammatory disease, by demographic and military characteristics, female active component service members, U.S. Armed Forces, 1996–2016

	No.	Rate[a]
Total	22,992	6.0
Age (years)		
17–24	15,054	8.9
25–34	6,483	4.5
35+	1,455	2.1
Race/ethnicity		
Non-Hispanic white	9,289	4.9
Non-Hispanic black	8,594	8.2
Hispanic	2,826	6.4
Other/unknown	2,283	5.1
Service		
Army	10,408	7.9
Navy	5,299	5.3
Air Force	5,665	4.4
Marine Corps	1,620	7.1
Rank		
Enlisted	22,016	7.0
Officer	976	1.5
Marital status		
Single	12,207	6.8
Married	9,022	5.2
Other/unknown	1,763	5.6
Education level		
High school or less	19,098	7.7
College or more	3,894	2.9
Previous chlamydia/gonorrhea infection		
No	17,873	5.2
Yes	5,119	13.2

[a]Rate per 1,000 person-years

FIGURE 1. Annual incidence rates of acute pelvic inflammatory disease, female active component service members, U.S. Armed Forces, 1996–2016

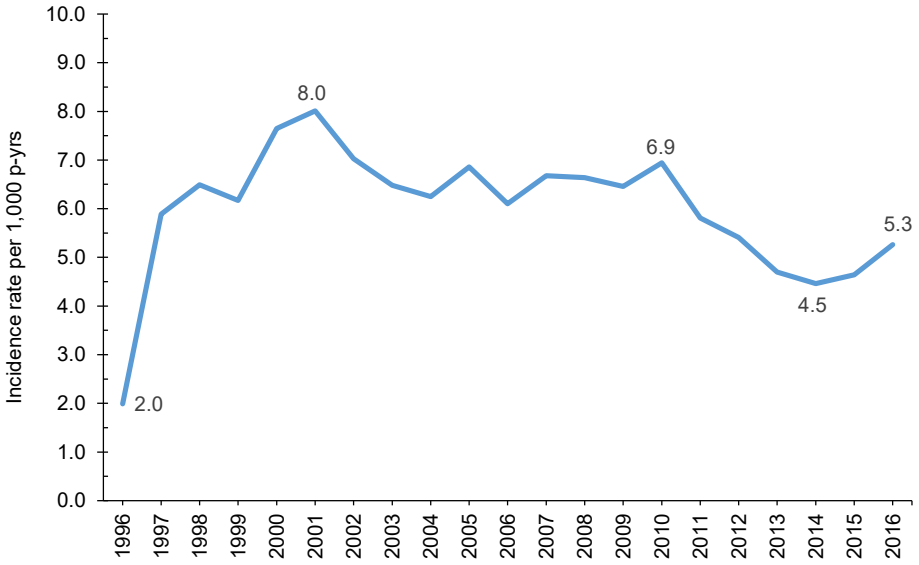
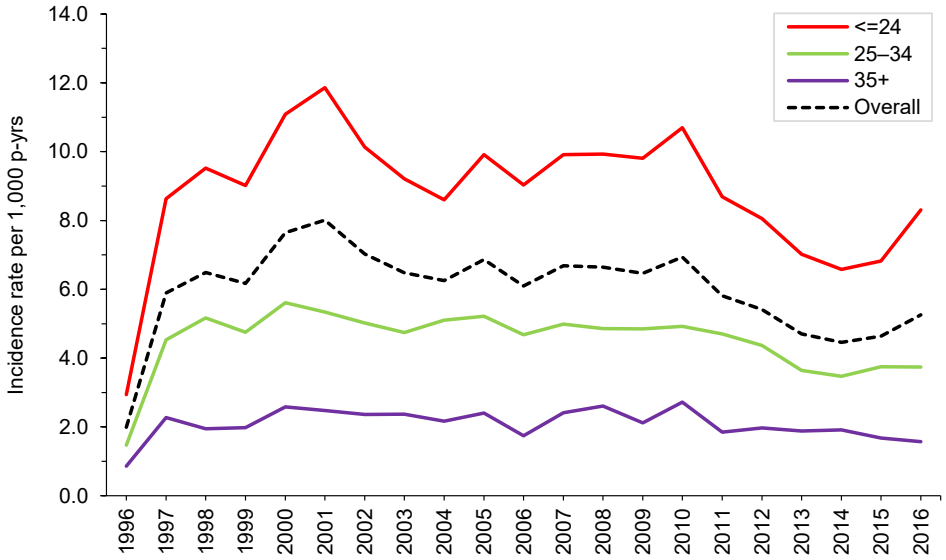


FIGURE 2. Annual incidence rates of acute pelvic inflammatory disease, by age group, female active component service members, U.S. Armed Forces, 1996–2016



of CT/GC (PID rate: 13.2 per 1,000 p-yrs) were 2.5 times more likely to have a diagnosis of acute PID, compared with those without a previous diagnosis of CT/GC (5.2 per 1,000 p-yrs) **(Figure 4)**. Nearly 20% of the women who had a previous CT/GC diagnosis received a diagnosis of acute PID within 30 days of the CT/GC diagnosis **(data not shown)**. Service women with a previous CT/GC diagnosis had higher incidence rates of acute PID across all demographic subgroups **(Figure 4)**. Service women aged 24 years or younger with a previous diagnosis of CT or GC were 2.6 times more likely to have a diagnosis of PID (20.0 per 1,000 p-yrs), compared with those service women in the same age group without a previous CT/GC diagnosis (7.6 per 1,000 p-yrs). Those service women aged 25–34 years with a previous diagnosis of CT/GC were 2.1 times more likely to have a subsequent diagnosis of acute PID (8.2 per 1,000 p-yrs), compared with those service women aged 25–34 years without a previous CT/GC diagnosis (4.0 per 1,000 p-yrs) **(Figure 4)**. Non-Hispanic white women with a previous diagnosis of CT/GC were three times as likely to be diagnosed with acute PID (12.8 per 1,000 p-yrs) compared with non-Hispanic white service women with no previous CT/GC diagnosis (4.3 per 1,000 p-yrs). Non-Hispanic black service women with a previous CT/GC diagnosis were two

FIGURE 3. Annual incidence rates of acute pelvic inflammatory disease, by service, female active component service members, U.S. Armed Forces, 1996–2016

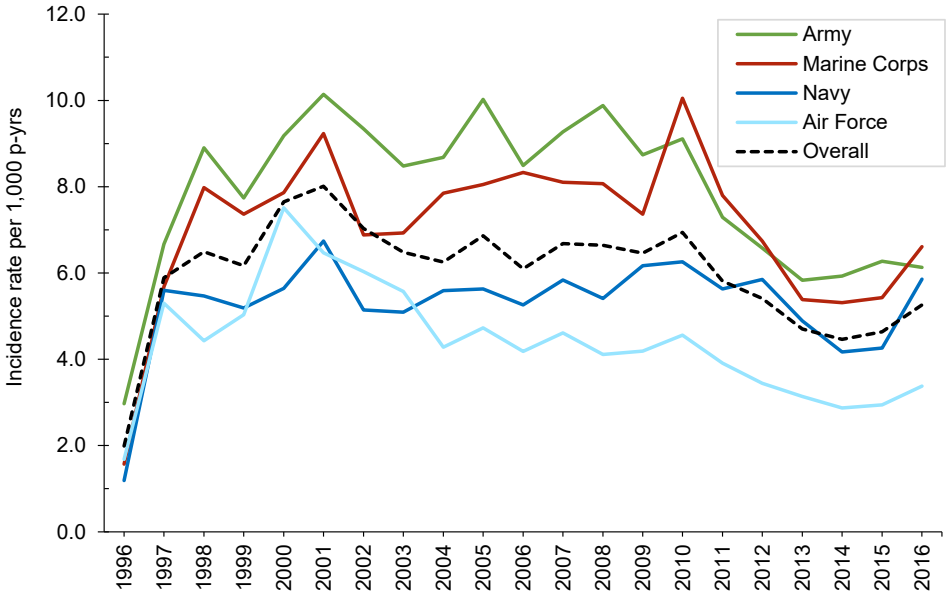
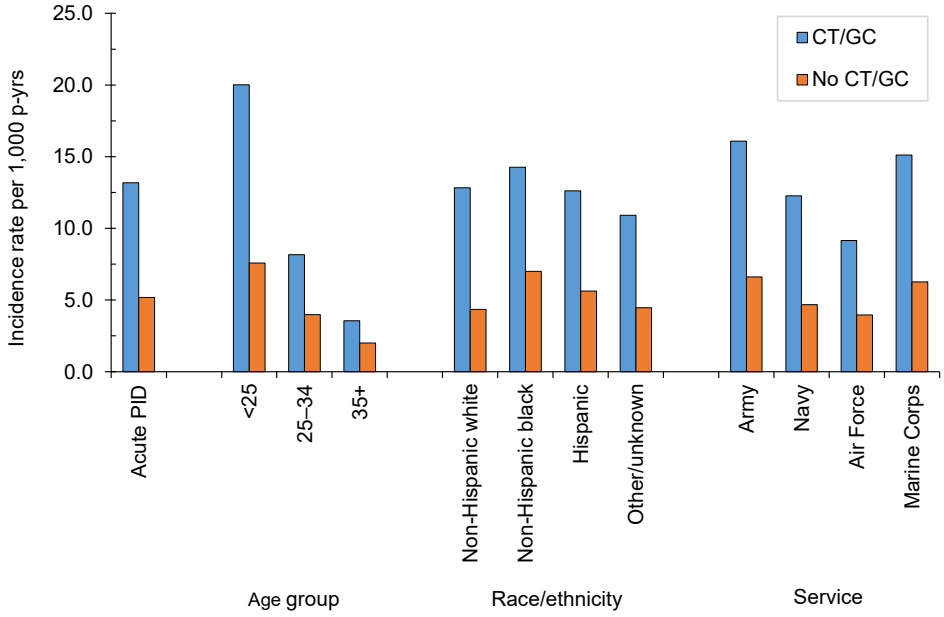


FIGURE 4. Overall incidence rates of acute pelvic inflammatory disease (PID) with/without previous chlamydia/gonorrhea (CT/CG) diagnosis, by demographic characteristics and service, female active component service members, U.S. Armed Forces, 1996–2016



times as likely to be diagnosed with acute PID (14.3 per 1,000 p-yrs), compared with non-Hispanic black service women who did not have a previous CT/GC diagnosis (7.0 per 1,000 p-yrs) **(Figure 4)**.

The overall incidence rate of acute PID among active component service women with two or more previous diagnoses of CT/GC was 2.8 times that of service women with no previous CT/GC diagnoses (14.4 per 1,000 p-yrs and 5.2 per 1,000 p-yrs, respectively); service women with a single previous CT/GC diagnoses had 2.5 times the rate of acute PID (12.9 per 1,000 p-yrs), compared with women with no previous CT/GC diagnoses **(Figure 5)**.

Among the service women diagnosed with acute PID who remained in service for at least another 4 years (n=10,014, 43.6%), 6.2% received a first-ever infertility or ectopic pregnancy diagnosis within the subsequent 4 years **(data not shown)**. The proportions of service women who experienced these sequelae were highest among women in the Army and among those aged 25–34 years **(Figure 6)**.

EDITORIAL COMMENT

This report documents a decrease in the annual incidence rates of acute PID diagnoses from 1997 through 2016 among active component service women. The lowest rates were observed across all demographic subgroups in 1996. The low rate of PID in 1996 can be attributed to that being the first year for which outpatient data were available in the DMSS and such data were incomplete for that year. Overall and throughout the stratified results, steady declines in acute PID were noted after 2001. It was around this time that the services were in various stages of routine CT/GC screening for service women, leading up to full implementation of CDC-recommended screening in 2005. The overall declines in acute PID beginning in the early to mid-2000s may be a reflection of these screening practices. As mentioned earlier, the U.S. general population saw an overall decline in initial visits for acute PID by 36% from 2006 through 2015.[9] Among all active component females during this same period, numbers of initial acute PID diagnoses decreased by 18%. This decrease is consistent with previous reports which show that military rates of STIs and acute PID typically mirror those of national trends.[13]

The highest rates of acute PID were observed among Army and Marine Corps service women, compared with women in the other services. It was expected that those services that had been routinely screening female recruits for CT/GC would have lower incidence rates of acute PID. However, the results presented here do not suggest that additional recruit screening for CT/GC by the Marine Corps affected rates of acute PID when compared to the Army, which does not screen recruits at the time of entry into service. Across all branches of service, it was expected that a

FIGURE 5. Overall incidence of acute pelvic inflammatory disease, by number of prior chlamydia/gonorrhea (CT/GC) diagnoses, female active component service members, U.S. Armed Forces, 1996–2016

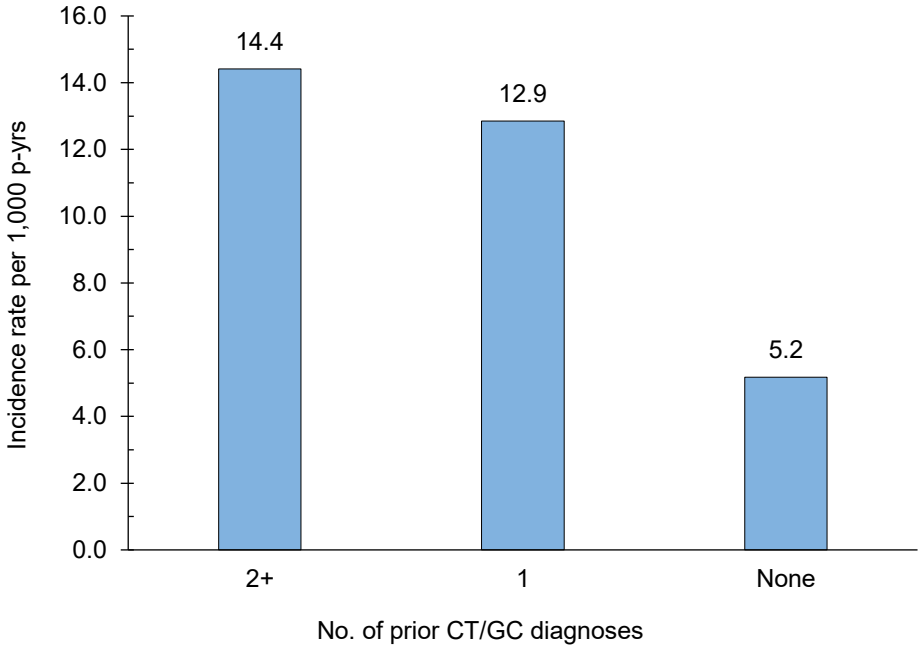
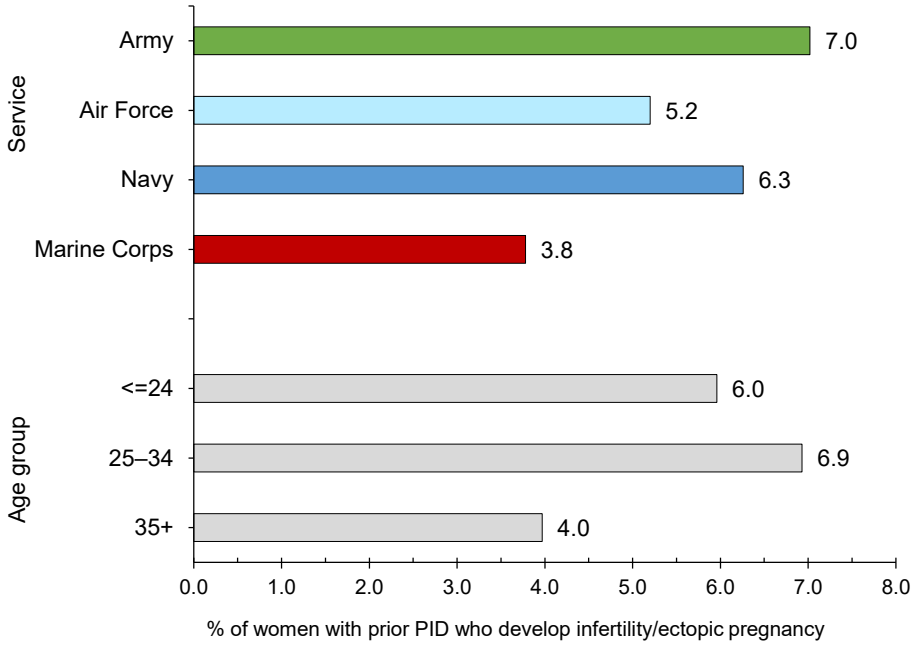


FIGURE 6. Proportions of women with previous diagnoses of acute pelvic inflammatory disease (PID) who develop infertility/ectopic pregnancy within 4 years of acute PID diagnosis, by service and age group, active compoment service women, U.S. Armed Forces



marked decline in acute PID would be evident beginning in 2005 with the implementation of servicewide screening practices; however, the only steady decline during this time period was noted among women in the Air Force. After 2010, all services experienced steady declines in rates of acute PID.

Overall, there was higher incidence of acute PID among women who had a previous diagnosis of CT/GC. Compared with women with no previous diagnosis of CT or GC, women with one previous diagnosis of CT/GC were more than twice as likely to have a subsequent acute PID diagnosis, and women with two or more previous CT/GC diagnoses were almost three times as likely to receive a subsequent acute PID diagnosis. These findings are consistent with other studies that showed a dose–response relationship between the numbers of diagnoses of STIs and subsequent sequelae of those diagnoses.[14]

Among those who had a diagnosis of acute PID between 1996 and 2012 and remained in service for at least 4 years, 6.2% were subsequently diagnosed with infertility or ectopic pregnancy. Women aged 25–34 years who were diagnosed with acute PID had the highest proportion of infertility or ectopic pregnancy, compared with women in other age groups. Because the average age of service women at the birth of their first child is 25.8 years old,[15] the high percentage of sequelae among women aged 25–34 years could be related to more women in this age group attempting pregnancy. The highest proportions of infertility or ectopic pregnancy were found among active component females in the Army, followed by Navy, Air Force, and Marine Corps. This finding is consistent with a recent *MSMR* report noting that women in the Army had the highest live birth rates from 2012 through 2016.[15] Because more women in the Army may be attempting to become pregnant, it is more likely that these sequelae from acute PID would be diagnosed.

Limitations of this study include selection bias when assessing the sequelae of acute PID. For example, women are more likely to be diagnosed with infertility or ectopic pregnancy if they are attempting to become pregnant. Active component women with a diagnosis of acute PID may leave the service before attempting pregnancy for reasons related to a common risk factor (such as age), and their data would not have been captured in this analysis. Because this report is based on ICD-9/ICD-10 diagnostic codes, it is possible that diagnoses were miscoded or missing, especially because laboratory data were not used to confirm CT/GC diagnoses. In addition, the reported incidence of PID by service is potentially confounded by other factors

such as age and race/ethnicity, which were not adjusted for in these analyses. Finally, acute PID is caused by other STIs and even normal flora, but this report examined only CT/GC diagnoses.

The overall decrease in rates of acute PID nationally and among active component women is encouraging. Continued screening for PID should result in a decrease in the incidence of acute PID over time.

Author affiliations: General Preventive Medicine Residency, Uniformed Services University of the Health Sciences, Bethesda, MD (LCDR McKee); AFHSB, Silver Spring, MD (Dr. Stahlman, Ms. Hu).

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Psychiatric Medical Evacuations in Individuals with Diagnosed Pre-Deployment Family Problems, Active Component, U.S. Armed Forces, 2002–2014

Brianna L. Rupp, DO (LCDR, USN); Saixia Ying, PhD; Shauna L. Stahlman, PhD, MPH

This study evaluated incidence of pre-deployment family problem diagnoses and psychiatric medical evacuations among a population of active component service members without a history of previous mental health diagnoses, who deployed to the U.S. Central Command Area of Responsibility for the first time between 1 January 2002 and 31 December 2014. During the surveillance period, 6,182 service members received an incident family problem diagnosis during the pre-deployment period, with an overall incidence of 5.6 cases per 1,000 deployers. The incidence of pre-deployment family problem diagnoses was generally stable over the study period. Compared to their respective counterparts, rates of pre-deployment family problems were highest among females, non-Hispanic black service members, those who were married, enlisted service members, and Army members. A total of 2,190 active component service members were evacuated from theater for psychiatric reasons, with an overall incidence rate of 3.1 per 1,000 deployed person-years. Of evacuated service members, 1.7% had diagnosed pre-deployment family problems (N=38). Incidence of psychiatric medical evacuation was consistently higher among those with pre-deployment family problems among all demographic subgroups, and overall was 2.7 times the incidence among those without documented family problems.

A recent National Institutes of Health report placed the past-year prevalence of any mental illness at 18.3% among U.S. adults in 2016.[1] A comparable period prevalence estimate of 15.5% was reported for 2016 among the U.S. active duty population (up from 9.2% in 2005).[2] For the active duty population mental health disorders are not only a significant cause of morbidity and disability, but also a threat to readiness through attrition from military service.[3] Rates of separation from military service are much higher in individuals with mental health disorders than other illness categories. One study of all active duty service members who accessed care in outpatient military clinics in 2000 reported attrition rates after 1 year of 38.3% among service members with mental health disorder diagnoses and 23.3% for mental health V-code diagnoses (vs. 14.3% for those receiving healthcare for any other reason).[4] V-codes differ from diagnosis codes in that mental health V-code diagnoses are designed for circumstances when a problem (such as partner relationship problems) is the focus of treatment and the individual does not meet criteria for a mental health disorder.[5]

In addition to common risk factors for mental health disorders experienced by the general U.S. population (such as family history, drug or alcohol abuse, family or financial stressors, and/or ongoing medical conditions), military members may encounter additional stressors such as combat exposure and family separation.[6,7] Studies suggest that experiencing multiple simultaneous sources of stress may contribute to more severe mental illness.[8] Increased odds of suicide have been associated with partner relationship and family circumstance problems, with suicide death rates 23.7% higher in divorced/separated than single/never-married service members.[9,10] In contrast, sources of strength (such as positive family relationships and satisfaction with social support) may have a protective effect.[7,8] The 2009 RAND Deployment Life Study found families that participated in pre-deployment readiness activities had better post-deployment outcomes in family functioning than families that did not.[11]

The stresses of deployment can challenge the psychological strength of even the most seasoned service member. Despite efforts to screen for mental health disorders in the pre-deployment period, many active duty personnel develop such disorders during deployment, and more severe cases may require medical evacuation from theater.[12] For deployments conducted in support of Operation Enduring freedom (OEF) and Operation Iraqi Freedom (OIF), mental health disorders accounted for 12.0% of all medical evacuations during 2001–2012 and increased to 19.2% during 2013–2015, becoming the most common cause of medical evacuations from theater.[13,14] Recent rates of medical evacuation for mental health disorders were higher among individuals aged 40 years or older, females, service members in the Army or Marine Corps, enlisted personnel, those with lower education level, and those in combat-specific occupations.[7,14] In a study of psychiatric evacuations from OEF/OIF, 67.1% of evacuations occurred during a service member's first deployment, and only 10.1% of evacuees returned to theater to complete their deployments.[7]

No studies have evaluated the association between pre-deployment family problems and medical evacuation rates from

theater. The purposes of this study were to examine the incidence of family problems during the pre-deployment period among active component military members, and to examine the association between pre-deployment family problems and psychiatric medical evacuation from theater.

METHODS

The surveillance period covered deployments with start dates on or between 1 January 2002 and 31 December 2014. The study population included all active component members of the U.S. Army, Navy, Air Force, and Marine Corps with first-ever deployments to the U.S. Central Command (CENTCOM) area of responsibility (AOR) during the surveillance period. Individuals were excluded if they had a pre-deployment diagnosis of a mental health disorder, defined by having a previously documented diagnosis for a condition with an ICD-9 code in the 290.0–319.0 range (excluding 305.1 for tobacco use disorder) in the 1st or 2nd diagnostic position in the record of any inpatient encounter, or of two outpatient medical encounters (within 180 days of each other), or of one outpatient encounter in a mental health–related specialty setting, at any time prior to the first-ever deployment. Also excluded were individuals with pre-existing family problem diagnoses, defined as meeting the definition for a family problem case at any time prior to the start of the pre-deployment period.

The exposure of interest was family problems, defined by having any outpatient or inpatient medical encounter with a qualifying diagnosis based on selected ICD9 V-codes **(Table 1)** in any diagnostic position, occurring for the first time during the pre-deployment period of a service member's first-ever deployment. Of all V-codes for mental health problems, only those pertaining to family problems were studied. The pre-deployment period was defined as the 6 months immediately prior to deployment. Deployment start dates were determined using data from the Defense Manpower Data Center (DMDC) Contingency Tracking System, which are maintained in the Defense Medical Surveillance System (DMSS). If a deployment end date was missing, the end date was imputed based on average deployment times specific to service, component, and operation.

TABLE 1. V-codes included in the case definition for family problems

V61.0 Family disruption
V61.01 Family disruption due to family member on military deployment
V61.03 Family disruption due to divorce or legal separation
V61.04 Family disruption due to parent-child estrangement
V61.05 Family disruption due to child in welfare custody
V61.06 Family disruption due to child in foster care or in care of non-parental family member
V61.07 Family disruption due to death of family member
V61.08 Family disruption due to other extended absence of family member
V61.09 Other family disruption
V61.1 Counseling for marital and partner problems
V61.10 Counseling for marital and partner problems, unspecified
V61.11 Counseling for victim of spousal and partner abuse
V61.12 Counseling for perpetrator of spousal and partner abuse
V61.2 Parent-child problems
V61.20 Counseling for parent-child problem, unspecified
V61.21 Counseling for victim of child abuse
V61.22 Counseling for perpetrator of child abuse
V61.23 Counseling for parent-biological child problem
V61.24 Counseling for parent-adopted child problem
V61.25 Counseling for parent (guardian)-foster child problem
V61.29 Other parent-child problems
V61.3 Problems with aged parents or in-laws
V61.4 Health problems within family
V61.41 Alcoholism in family
V61.42 Substance abuse in family
V61.49 Other health problems within the family
V61.8 Other specified family circumstances
V61.9 Unspecified family circumstances

The outcome of interest was a medical evacuation for psychiatric reasons from the CENTCOM AOR to a medical treatment facility outside of CENTCOM. A medical evacuation was considered psychiatric if there was an ICD-9 diagnostic code in the 290.0–319.0 range (or ICD-10 code in the F01.00–F99.00 range) listed in either the 1st or 2nd diagnostic position (excluding 305.1 or F17.200 for tobacco use disorder). Medical evacuations were included if they occurred between the deployment start date and up to 90 days after the deployment end date, to account for discrepancies between inaccurate or imputed deployment end dates and actual medical evacuation dates. All medical evacuation data (including diagnostic codes) were retrieved from the U.S. Transportation Command (TRANSCOM) Regulating and Command and Control Evacuation System (TRAC2ES).

For all members of the surveillance population, data captured for the covariates of interest included age, sex, race/ethnicity, marital status, military rank/grade, branch of service, primary occupational category, and deployment length in days. The overall incidence of pre-deployment family problems was calculated per 1,000 deployers for the entire study period as well as for individual calendar years of

the surveillance period. The overall incidence of pre-deployment family problems was stratified by demographic and military characteristics. The incidence of medical evacuations for psychiatric reasons among those with and without pre-deployment family problems was calculated per 1,000 deployed person-years (dp-yrs). Denominators for deployed person-time were calculated using the length of each individual's deployment, which was censored at the time of medical evacuation.

RESULTS

Pre-deployment family problems

During the 13-year surveillance period, a total of 6,182 active component service members had incident diagnoses for family problems during the pre-deployment period, with a crude overall incidence of 5.6 cases of family problems per 1,000 deployers **(Table 2).** Approximately five times as many males (n=5,151) as females (n=1,031) had medical encounters for pre-deployment family problems. However, the incidence of pre-deployment family problems was 68.0% higher among females (8.7 per 1,000 deployers) compared to males (5.2 per 1,000 deployers). The overall incidence rate was highest among non-Hispanic black service members (9.8 per 1,000 deployers) and lowest among Asian/Pacific Islanders (3.8 per 1,000 deployers). The overall rate was higher for service members aged 20–39 years when compared to older and younger age groups. Overall, the incidence of pre-deployment family problems was highest among married service members (11.2 per 1,000 deployers), who had an incidence more than six times that of single/never-married individuals (1.8 per 1,000 deployers). Slightly more than half (52.7%) of incident pre-deployment family problems were for counseling for marital and partner problems, and 20.7% were for "other specified family circumstances" **(data not shown)**.

Stratification by military rank/grade showed that the overall incidence rate among enlisted service members (6.0 per 1000 deployers) was nearly three times the rate among officers (2.1 per 1,000 deployers) **(Table 2)**. Compared to their respective counterparts, incidence of pre-deployment family problems was highest among service members in the Army (8.8 per 1,000 deployers) and lowest among Navy members (0.9 per 1,000 deployers). Health care and communications/intelligence were the primary occupational categories with the highest incidence (6.4 per 1,000 deployers) and pilots/air crew had the lowest (2.3 per 1,000 deployers). Overall incidence of pre-deployment family problems also increased with increasing length of deployment**.**

Crude annual incidence rates of pre-deployment family problems increased from 3.1 cases per 1,000 deployers in 2002 to 6.3 cases per 1,000 deployers in 2003 (rate ratio, 2003 vs. 2002: 2.03; 102.6%), after which rates peaked in 2007 at 7.1 cases per 1,000 deployers. After this peak, rates remained relatively stable and ranged from 5.5 cases per 1,000 deployers in 2008 to 5.0 cases per 1,000 deployers in 2014 **(Figure 1).** During the 13-year surveillance period, annual incidence rates of pre-deployment family problems were markedly and consistently higher among Army members, intermediate among Air Force members, and lowest among Navy and Marine Corps members **(Figure 2)**.

Psychiatric medical evacuations among those with and without pre-deployment family problems

During the 13-year surveillance period, a total of 2,190 active component service members (meeting inclusion criteria) were evacuated from theater for psychiatric reasons, with an overall incidence rate of 3.1 psychiatric medical evacuations per 1,000 deployed person-years. Of all evacuated service members, 1.7% had incident pre-deployment family problems (N=38) while the remainder did not (N=2,152). Due to this relatively small number of medical evacuations among those with pre-deployment family problems, demographic subgroups were collapsed into broader categories (e.g., Army vs. all other service branches). Overall, active component service members with pre-deployment family problems were 2.7 times as likely to be evacuated for psychiatric reasons compared to

TABLE 2. Crude incidence of pre-deployment family problems, active component, U.S. Armed Forces, 2002–2014

Year	2002–2014		
	N	Rate[a]	IRR
Total	6,182	5.6	
Sex			
Male	5,151	5.2	ref
Female	1,031	8.7	1.68
Age			
<20	1,006	3.4	ref
20–24	2,662	6.1	1.79
25–29	1,481	6.9	2.03
30–34	651	7.7	2.27
35–39	268	6.2	1.81
40–44	94	4.4	1.29
45+	20	2.2	0.65
Race/ethnicity			
Non-Hispanic white	3,486	4.9	ref
Non-Hispanic black	1,602	9.8	2.03
Hispanic	696	5.3	1.09
Asian/Pacific Islander	147	3.8	0.78
Other/unknown	251	4.4	0.90
Military rank/grade			
Jr. Enlisted (E1–E4)	4,774	5.9	ref
Sr. Enlisted (E5–E9)	1,103	6.3	1.06
Jr. Officer (O1–O3)	238	2.2	0.37
Sr. Officer (O4–O10)	19	2.0	0.34
Warrant Officer (W1–W5)	48	6.6	1.11
Service			
Army	4,919	8.8	ref
Air Force	922	4.4	0.50
Navy	96	0.9	0.11
Marine Corps	245	1.1	0.12
Primary occupational category			
Combat-specific[b]	1,549	4.9	ref
Pilot/air crew	72	2.3	0.47
Repair/engineering	1,691	5.7	1.17
Communications/intelligence	1,481	6.4	1.31
Health care	428	6.4	1.31
Other/unknown	961	5.9	1.22
Deployment length in days			
0–90	630	4.5	ref
91–180	1,185	4.5	1.02
181–360	2,903	5.4	1.22
361–420	725	8.2	1.83
>420	739	9.2	2.07
Marital status			
Married	4,794	11.2	ref
Single, never married	1,208	1.8	0.16
Other	174	7.4	0.67
Unknown/missing	6	8.9	0.80

IRR, incidence rate ratio

[a]Number of cases per 1,000 individuals

[b]Infantry/artillery/combat engineering/armor/motor transport

FIGURE 1. Incidence rates of pre-deployment family problems, by deployment year, active component, U.S. Armed Forces, 2002–2014

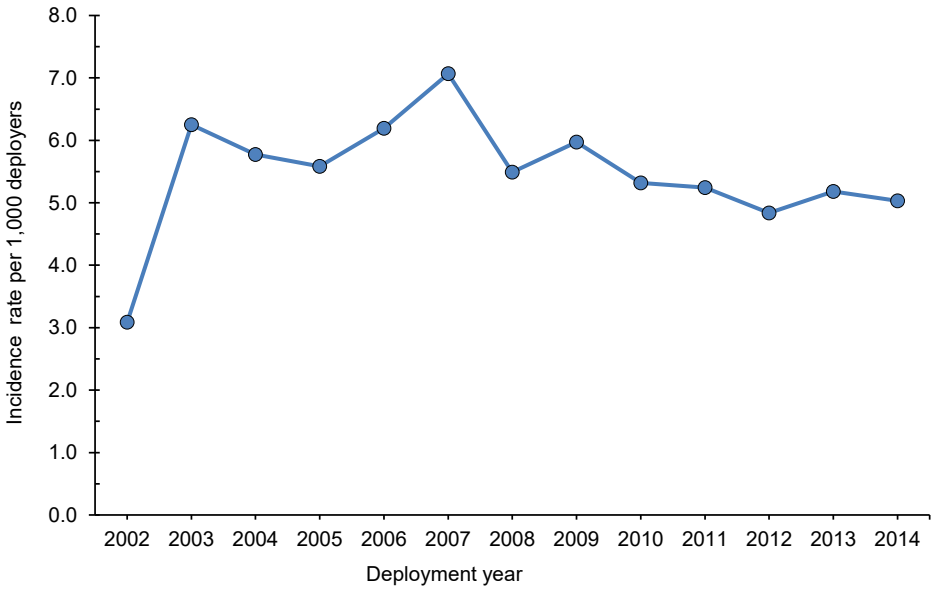
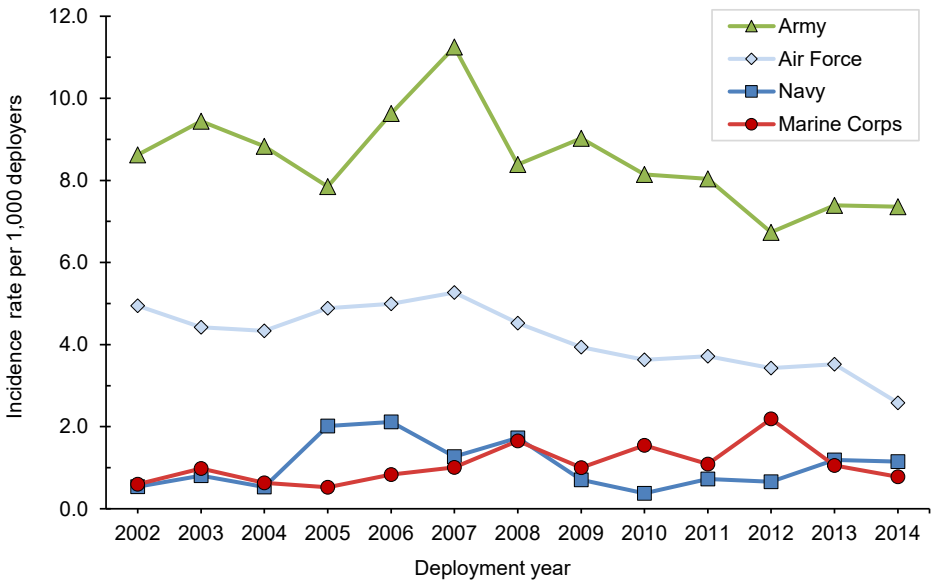


FIGURE 2. Incidence rates of pre-deployment family problems, by deployment year and service, active component, U.S. Armed Forces, 2002–2014



individuals without pre-deployment family problems.

Across nearly all demographic and military characteristics, individuals with incident pre-deployment family problems had a higher incidence of psychiatric medical evacuation from theater **(Table 3)**. The rate of psychiatric medical evacuation among those with incident pre-deployment family problems was highest among individuals aged 20–34 years. The rate was also 2.8 times the rate for men and 2.1 times the rate for women when compared to those without pre-deployment family problems. Among both those with and without incident pre-deployment family problems, the rates of psychiatric medical evacuation were higher among enlisted and particularly junior enlisted ranks. The crude rate ratio for all enlisted ranks combined was 2.6 for service members with pre-deployment family problems when compared to those without. Compared to other service branches, the overall incidence of psychiatric medical evacuations was highest among service members in the Army, and Army personnel with pre-deployment family problems were 2.2 times as likely to be evacuated for psychiatric reasons compared to individuals without. This rate ratio was higher for all other branches of service (5.5); however, there was a much smaller number of medical evacuations among the other service branches. Finally, rates of medical evacuations for psychiatric reasons were highest in the first 90 days of deployment among individuals both with and without pre-deployment family problems **(Table 3)**.

EDITORIAL COMMENT

V-coded diagnoses for family problems were relatively common in this study, occurring for the first time during the pre-deployment period with an overall incidence of 5.6 cases per 1,000 deployers. Compared to their respective counterparts, incidence rates of pre-deployment family problems were higher among female, married, enlisted, Army, and non-Hispanic black service members. Prior studies have hypothesized that higher rates of mental health disorder diagnoses in women may be due to gender differences in social support needs. These differences may impact family problem V-code diagnoses as well. Women may rely more heavily on support from peers and families to cope with the stresses of deployment compared to men.[15] Also, deployment may increase the impact of family responsibilities felt by women.[16] Socioeconomic factors may play a role in the difference seen between officers and enlisted, with prior studies showing higher rates of mental health disorders in lower socioeconomic groups.[17,18] In terms of the difference between branches, prior studies have hypothesized that higher rates of mental health disorder diagnoses in the Army may be due to the primarily combat and ground-based operations of this branch.[3,19] However, studies have also

TABLE 3. Overall incidence rates of psychiatric medical evacuations among service members with and without pre-deployment family problems, active component, U.S. Armed Forces, 2002–2014

	Total 2002–2014			With pre-deployment family problems 2002–2014			Without pre-deployment family problems 2002–2014			
	N	Rate[a]	IRR	N	Rate[a]	IRR	N	Rate[a]	IRR	Crude RR[b]
Total	2,190	3.1	·	38	8.3	·	2,152	3.1	·	2.7
Sex										
Male	1,845	2.9	ref	31	8.0	ref	1,814	2.9	ref	2.8
Female	345	4.9	1.69	7	10.2	1.27	338	4.9	1.69	2.1
Age										
<20	809	4.1	ref	2	2.7	ref	807	4.1	ref	0.7
20–24	858	3.1	0.76	20	10.2	3.81	838	3.1	0.75	3.3
25–29	310	2.3	0.57	12	11.1	4.15	298	2.3	0.55	4.9
30–34	133	2.5	0.61	4	8.2	3.08	129	2.5	0.60	3.3
35–39	51	1.9	0.47	0	.	.	51	1.9	0.48	.
40–44	23	1.9	0.46	0	.	.	23	1.9	0.46	.
45+	6	1.2	0.29	0	.	.	6	1.2	0.29	.
Race/ethnicity										
Non-Hispanic white	1,497	3.3	ref	24	9.4	ref	1,473	3.3	ref	2.9
Non-Hispanic black	330	3.1	0.95	8	6.6	0.70	322	3.1	0.95	2.1
Hispanic	209	2.5	0.75	3	5.6	0.60	206	2.5	0.75	2.3
Asian/Pacific Islander	82	3.1	0.94	1	8.8	0.94	81	3.1	0.94	2.9
Other/unknown	72	2.2	0.68	2	12.9	1.37	70	2.2	0.67	5.9
Military rank/grade										
Jr. Enlisted (E1–E4)	1,988	3.8	ref	34	9.5	ref	1,954	3.7	ref	2.5
Sr. Enlisted (E5–E9)	125	1.2	0.33	4	5.2	0.55	121	1.2	0.32	4.3
Jr. Officer (O1–O3)	72	1.1	0.29	0	.	.	72	1.1	0.29	.
Sr. Officer (O4–O10)	4	0.8	0.22	0	.	.	4	0.8	0.22	.
Warrant Officer (W1–W5)	1	0.2	0.05	0	.	.	1	0.2	0.05	.
Service										
Army	1,724	3.8	ref	33	8.1	ref	1,691	3.7	ref	2.2
Air Force	103	1.6	0.42	3	10.2	1.26	100	1.5	0.41	6.6
Navy	70	1.4	0.38	1	21.0	2.60	69	1.4	0.37	15.1
Marine Corps	293	2.3	0.60	1	7.3	0.91	292	2.2	0.60	3.3
Primary occupational category										
Combat-specific[c]	872	3.8	ref	11	8.5	ref	861	3.8	ref	2.3
Pilot/air crew	3	0.2	0.06	0	.	.	3	0.2	0.06	.
Repair/engineering	441	2.5	0.67	7	5.9	0.69	434	2.5	0.66	2.4
Communications/intelligence	443	3.0	0.79	11	10.4	1.22	432	2.9	0.78	3.5
Health care	149	3.6	0.94	4	13.0	1.53	145	3.5	0.93	3.7
Other	282	3.0	0.78	5	7.4	0.87	277	2.9	0.78	2.5
Deployment length (in days)										
0–90	458	25.3	ref	8	90.8	ref	450	25.0	ref	3.6
91–180	686	7.2	0.28	14	32.2	0.35	672	7.1	0.28	4.6
181–360	844	2.2	0.09	15	6.6	0.07	829	2.2	0.09	3.0
361–420	97	1.0	0.04	0	.	.	97	1.1	0.04	.
>420	105	0.9	0.04	1	1.0	0.01	104	0.9	0.04	1.1
Marital status										
Married	849	3.2	ref	31	8.8	ref	818	3.1	ref	2.8
Single, never married	1,296	3.1	0.95	7	7.9	0.90	1,289	3.0	0.97	2.6
Other	44	3.0	0.95	0	.	.	44	3.1	0.98	.
Unknown/missing	1	3.5	1.08	0	.	.	1	3.5	1.12	.

[a]Number of cases per 1,000 deployed person-years

[b]Incidence rate among those with pre-deployment family problems/rate among those without pre-deployment family problems

[c]Infantry/artillery/combat engineering/armor/motor transport

shown higher rates of psychiatric medical evacuation among Army personnel in non-combat occupations (such as medical, food service, and laundry).[7] It is possible that differences between branches, such as waiver criteria or deployment-related stressors, may be factors in psychiatric medical evacuation rates.

The crude annual incidence rates of pre-deployment family problems were relatively stable over the study period, with some exceptions. An increase in incident V-code diagnoses noted in 2007 coincided with a surge in the numbers of deployed troops beginning in January 2007, which may have reflected stress felt by families where the service member was anticipating an extended deployment.[20]

Several studies cite mental health disorders as one of the leading reasons for medical evacuation from theater. The current study used a pre-defined population with no prior history of mental health diagnoses or family problems; therefore, the results should not be interpreted as overall psychiatric medical evacuation rates for all service members. Results did demonstrate similar trends as compared to prior studies with rates of psychiatric medical evacuations higher among females, non-Hispanic white, junior enlisted, Army personnel, and combat-specific occupations.[13,14]

No prior studies were found to have examined the relationship between V-codes and medical evacuations from theater. One study documented a higher rate of attrition from military service for service members with mental health V-code diagnoses compared to service members with non-mental health related medical diagnoses.[4] In the current study, the incidence of psychiatric medical evacuation among those with pre-deployment family problems was almost three times the incidence among those without documented family problems. This finding suggests a link between pre-deployment family problems and an increased rate of psychiatric medical evacuation from theater. However, the number of psychiatric medical evacuations among those with pre-deployment family problems (N=38) was small and the majority of these evacuations involved Army personnel (N=33). Therefore, when comparing subgroups with and without pre-deployment family problems, rates should be interpreted in light of this small number.

There were several additional limitations to this study. The study population was limited to the first-ever deployment for a service member. Results, therefore, may not be generalizable to seasoned deployers. The fact that individuals with pre-existing mental health conditions were also excluded from this study may further limit generalizability. Although individuals with previous mental health disorder diagnoses were excluded from analysis, it is unlikely that all personnel with mental health disorders were captured and removed from the study. Multiple studies document underutilization of mental health resources by active duty personnel, and one study of combat infantry units reported that just 23%–40% of individuals who screened positive for a mental health disorder sought care.[19] This finding may be due to barriers to care in certain settings or perception of stigma associated with mental health disorders.[19] In addition, individuals with family problems may be more likely to have undiagnosed mental health disorders, which could have confounded the association between pre-deployment family problems and psychiatric medical evacuation.

The study population was limited to service members presenting to care for the first time for family problems during the 6-month pre-deployment period. Thus, family problems occurring prior to the pre-deployment period that were exacerbated by deployment may have been excluded from this study, which may have led to underestimation of the true impact of a deployment on the rate of family problems. Differences noted in incidence of pre-deployment family problems between branches of service may be due to misclassification bias rather than a true difference in rates. For example, there was a much higher rate of family problem diagnoses among members of the Army than any other branch. This finding may be due to differences in utilization rates of family counseling services between branches or differences in the rate of self-referral versus provider referral. Previous studies have documented differing rates of V-code use between branches, with the Army using proportionately more V-code diagnoses and the Navy and Marine Corps using more ICD-9 mental health disorder diagnoses.[4] Regardless, the overall number of visits for pre-deployment family problems is likely a significant underestimation of the true incidence and the cases identified in this study may reflect the more severe cases referred to providers.

For the outcome of psychiatric medical evacuation, data may be limited by the accuracy of diagnoses in the TRAC2ES records. A previous Armed Forces Health Surveillance Branch internal analysis suggested that there may be a difference between diagnoses reported in TRAC2ES and those reported in the first medical evaluation following evacuation from theater. This difference is likely due to the often emergent nature of medical evacuations, and the potential lack of specialized care available in theater. Finally, comparisons of rates of medical evacuations between subgroups (e.g., males and females) may be misleading because these crude rates do not account for potential confounding due to differences in other characteristics (e.g., age and grade) that may be significant risk factors for medical evacuation.

Although the number of individuals with pre-deployment family problems who experienced medical evacuation from theater was small, the results of this study at least suggest a link between pre-deployment family problems and an increased rate of psychiatric medical evacuation from theater, and this finding warrants further study. Programs addressing relationships within military families during the pre-deployment period may be important factors in future preventive efforts. Further studies focusing on pre-deployment family readiness activities may be beneficial to identify future areas of intervention.

Author affiliations: Uniformed Services University of Health Sciences, Bethesda, MD (LCDR Rupp); Armed Forces Health Surveillance Branch, Silver Spring, MD (Dr. Stahlman, Dr. Ying).

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Department of Defense End-of-Season Influenza Vaccine Effectiveness Estimates for the 2017–2018 Season

Robert Coleman, MPH, CPH; Angelia Eick-Cost, PhD, ScM; Anthony W. Hawksworth, BS; Zheng Hu, MS; LeeAnne Lynch, MPH; Christopher A. Myers, PhD; Laurie DeMarcus, MPH; Susan Federinko, MD, MPH (Lt Col, USAF)

The Department of Defense (DoD) generates influenza vaccine effectiveness (VE) estimates each season. The Armed Forces Health Surveillance Branch Air Force (AFHSB-AF) satellite, Naval Health Research Center Operational Infectious Disease Directorate at the Naval Health Research Center (NHRC-OID), and the Armed Forces Health Surveillance Branch (AFHSB) all conduct influenza surveillance and perform test-negative case-control analyses to estimate seasonal influenza VE for DoD populations. The midseason estimates contribute to the aggregate data utilized by the Food and Drug Administration's Vaccine and Related Biological Products Advisory Committee to select the composition of the influenza vaccine for the next influenza season. The full season data provide DoD with direct estimates for force health protection decisions. The 2017–2018 DoD influenza season was predominated by influenza A(H3N2) with varying levels of adjusted overall VE estimates. AFHSB-AF satellite's VE for dependents was moderate at 49% (95% confidence interval [CI]: 42%–55%) for all strains. NHRC-OID's VE among dependents was moderate-high at 63% (95% CI: 50%–73%) for all strains. AFHSB service member VE was low at 18% (95% CI: 4%–30%). These estimates highlight the need for continued influenza surveillance and VE estimate calculations each season among the different DoD populations as circulating strains and VE may change annually.

The influenza virus has the ability to critically impact the mission of the U.S. Armed Forces including lost duty time, financial burden, and impact on readiness. The Department of Defense (DoD) performs surveillance to track the spread and intensity of influenza illness each season, to detect novel strains of influenza viruses, and to assess vaccine effectiveness (VE) of vaccines used to help combat influenza. This report updates the DoD 2017–2018 midseason VE estimates described in an earlier analysis[1] and describes the influenza VE estimates for the 2017–2018 end-of-season from three DoD surveillance programs. These data help inform the DoD combatant commands in making critical decisions about force health protection for the U.S. military.

The Centers for Disease Control and Prevention (CDC) described the 2017–2018 influenza season in the U.S. as severe with significant prolonged levels of influenza activity across the nation. Fifty (93%) of the influenza surveillance jurisdictions in the U.S. reported widespread influenza activity for at least three consecutive weeks, the highest percentage in the past five seasons.[2] This was the first season during which the severity in each age group (children and adolescents, adults, and older adults) was classified as high in the same season based on a retrospective analysis of the data going back to the 2003–2004 season.[2] Key measures of severity for this study were outpatient clinic and emergency department (ED) visits for influenza-like illness (ILI), pneumonia and influenza-associated (P&I) mortality, and influenza-associated pediatric mortality. These findings were consistent with concerns regarding the Southern Hemisphere's low vaccine effectiveness (VE), particularly as seen in Australia during the 2017 influenza season that preceded the 2017–2018 influenza season in the U.S. The U.S. had selected the same vaccine strains as were used in the Southern Hemisphere where circulating strains were dominated by influenza A(H3N2). Australia's overall VE was 33% (95% CI: 17%–46%), and VE for influenza A(H3N2) was 10% (95% CI: -16%–31%), a VE not statistically different from zero.[3] Australia experienced large numbers of influenza cases during the 2017 season and the dominant A(H3N2) strain led to increased numbers of influenza-associated deaths, chiefly in the elderly.[4]

Each season, several entities within the DoD perform surveillance for influenza among beneficiaries and utilize these data to perform VE analyses to estimate how well the seasonal vaccine protects against medically attended influenza. The DoD representatives performing these tasks are the Armed Forces Health Surveillance Branch (AFHSB) Air Force satellite (AFHSB-AF) at the U.S. Air Force School of Aerospace Medicine (USAFSAM), the Operational Infectious Disease Directorate at the Naval Health Research Center (NHRC-OID), and the AFHSB of the Defense Health Agency.

METHODS

AFHSB-AF analysis utilized data from the DoD's global respiratory program, a DoD-wide sentinel site surveillance program. This program requests sentinel sites to submit 6–10 respiratory

specimens per week from DoD beneficiaries who meet an influenza-like illness (ILI) case definition (presence of a fever ≥100.5°F and either cough or sore throat within 72 hours of symptom onset). Respiratory specimens were collected by nasal wash or nasopharyngeal swab. Specimens were tested using a multiplex respiratory pathogen panel, reverse-transcriptase polymerase chain reaction (RT-PCR) and viral culture. Patient data were used in the AFHSB-AF analysis if the associated incident ILI encounter occurred between 12 November 2017 and 28 April 2018. Patients were classified by age group (children, 2–17 years; adults, 18 years or older), location (Eastern U.S., Western U.S., and outside continental U.S. [OCONUS]), and month of diagnosis. Vaccination status was determined using the Air Force Complete Immunization Tracking Application (AFCITA) or self-reported information from the questionnaire completed for each patient. Patients were considered vaccinated if they had received at least one influenza vaccine 14 days or more before an ILI encounter. Patients vaccinated less than 14 days prior to an ILI encounter, those without a vaccine history, service members, and those less than 2 years of age were excluded from the AFHSB-AF's analysis. Multivariable logistic regression was used to examine potential confounders for inclusion in the final adjusted VE models. Adjusted models included sex, age group, diagnosis month, and location.

NHRC-OID used data from its febrile respiratory illness (FRI) surveillance program to perform VE analysis of data from DoD beneficiaries and civilians living along the Mexico–U.S. border near San Diego, CA. NHRC-OID's analysis was restricted to data from individuals who presented to a participating outpatient clinic with a respiratory illness between 26 November 2017 and 21 April 2018 and who had a nasal or nasopharyngeal swab collected and tested for influenza. Testing was performed using RT-PCR. Age was categorized into three groups including children (0–17 years), adults (18–64 years), and the elderly (65 years or older). Each patient's vaccination status was determined through medical chart review or self-report. Patients were considered vaccinated if they received the influenza vaccine 14–180 days prior to specimen collection. Statistical models were adjusted for age group, study population (Mexico–U.S. border civilians and DoD beneficiaries), and diagnosis month (November–January or February–April).

AFHSB used vaccination and demographic data from the Defense Medical Surveillance System (DMSS) and HL7 formatted laboratory data from the Navy Marine Corps Public Health Center. AFHSB's analysis was restricted to active component service members who were tested for influenza between 1 December 2017 and 30 April 2018. Patients with an influenza positive laboratory result from a rapid, RT-PCR, or culture test were considered cases. Controls were individuals who tested negative for influenza by RT-PCR or culture. Patients with a negative rapid influenza test were excluded due to the high false negative rate. Statistical models were adjusted for age group, month of laboratory test, sex, and past five-season influenza vaccination status (as a dichotomous variable).

In all three studies, VE estimates were computed using a test-negative, case-control study design. All studies generated crude and adjusted VE using odds ratios (ORs) and 95% CIs derived from multivariable logistic regression models. Odds ratios were defined as the odds of a vaccinated person developing influenza divided by the odds of an unvaccinated person developing influenza. VE was calculated as (1-OR) × 100%. VE results were considered statistically significant if 95% CIs around VE estimates did not include zero. All statistical analyses were performed using SAS version 9.4 (SAS Institute, Cary, NC).

RESULTS

AFHSB-AF's VE analysis included 1,987 cases (41% vaccinated) and 2,251 controls (56% vaccinated) **(Table 1).** The overall adjusted VE for any influenza type was moderate at 49% (95% CI: 42–55). The adjusted VE for influenza A(H3N2) was low-moderate at 41% (95% CI: 30–50)

TABLE 1. AFHSB-AF satellite end-of-season influenza vaccine effectiveness (VE) estimates, DoD dependents, 2017–2018

Flu type	Population	Cases[a]		Controls		Crude VE		Adjusted VE[b]	
		No.	% vaccinated	No.	% vaccinated	(%)	95% CI	(%)	95% CI
Overall	All dependents	1,987	41	2,251	56	45	38–52	49	42–55
	Children	1,034	40	1,131	56	47	37–55	50	40–59
	Adults	953	41	1,120	56	44	33–53	50	39–58
A(H3N2)	All dependents	860	43	2,251	56	39	28–48	41	30–50
	Children	376	39	1,131	56	49	36–60	45	29–57
	Adults	484	47	1,120	56	29	12–43	38	21–51
A(H1N1)	All dependents	291	24	2,251	56	74	66–81	77	69–83
	Children	168	23	1,131	56	76	65–84	80	70–86
	Adults	123	26	1,120	56	72	57–81	72	56–82
Influenza B	All dependents	820	44	2,251	56	38	27–47	47	37–55
	Children	479	47	1,131	56	29	12–43	39	24–52
	Adults	341	39	1,120	56	49	34–60	56	42–66

CI, confidence interval
[a]Total number of cases in overall analyses includes unsubtyped influenza and dual influenza co-infections. Subtype analyses did not include these cases.
[b]Adjusted for age group, diagnosis month, sex, and geographic location (Eastern U.S., Western U.S., OCONUS)

TABLE 2. NHRC-OID end-of-season influenza vaccine effectiveness (VE) estimates, DoD beneficiaries and border civilians, 2017–2018

	Influenza type/study population	Cases		Controls		Crude VE		Adjusted VE[a]	
		No.	% vaccinated	No.	% vaccinated	(%)	95% CI	(%)	95% CI
Overall VE		452	16	626	36	65	52–74	63	50–73
Subtype	Flu A/H3	210	21	626	36	52	31–67	52	28–68
	Flu B	222	13	626	36	73	59–82	71	55–81
	B/Victoria	95	12	626	36	76	55–88	74	49–86
	B/Yamagata	127	14	626	36	70	50–82	69	47–82
Age group (A/H3N2)	Children	127	20	427	36	56	28–73	60	32–76
	Adults	74	20	182	35	53	11–75	41	-21–71
	Elderly	9	44	17	41	N/A			
Age group (B)	Children	163	12	427	36	75	58–85	73	56–84
	Adults	55	13	182	35	73	37–89	67	22–87
	Elderly	4	50	17	41	N/A			
Population (A/H3N2)	Border civilians	169	18	456	30	47	18–66	50	19–69
	DoD beneficiaries	41	32	170	51	56	9–79	56	7–79
Population (B)	Border civilians	188	13	456	30	66	45–79	65	44–78
	DoD beneficiaries	34	15	170	51	84	56–94	83	54–94

CI,confidence interval
[a]Adjusted for age group, study population, and diagnosis month

TABLE 3. AFHSB end-of-season influenza vaccine effectiveness (VE) estimates, active component service members, 2017–2018

	Cases[a]		Controls		Crude VE		Adjusted VE[b]	
Influenza type/subtype	No.	% vaccinated	No.	% vaccinated	(%)	95% CI	(%)	95% CI
Any influenza	4,096	91	5,274	93	32	9–18	18	4–30
Influenza A (any subtype)	3,281	91	5,274	93	22	9–34	16	1–29
A(H3N2)	489	92	5,274	93	13	-22–37	16	-19–40
Influenza B	823	91	5,274	93	20	-3–38	23	-1–42

CI, confidence interval
[a]Dual influenza co-infections were included in both the influenza A and influenza B analyses.
[b]Adjusted for age group, month of laboratory test (December–April), sex, past five-season influenza vaccination status (dichotomous)

while the adjusted VE for influenza B was moderate at 47% (95% CI: 37–55). The adjusted VE for influenza A(H1N1) pdm09 was high at 77% (95% CI: 69–83). Adjusted VE estimates were higher among children for both influenza A subtypes and lower for influenza B, compared to adults; all VE estimates were statistically significantly different from zero. **(Table 1, Figure).**

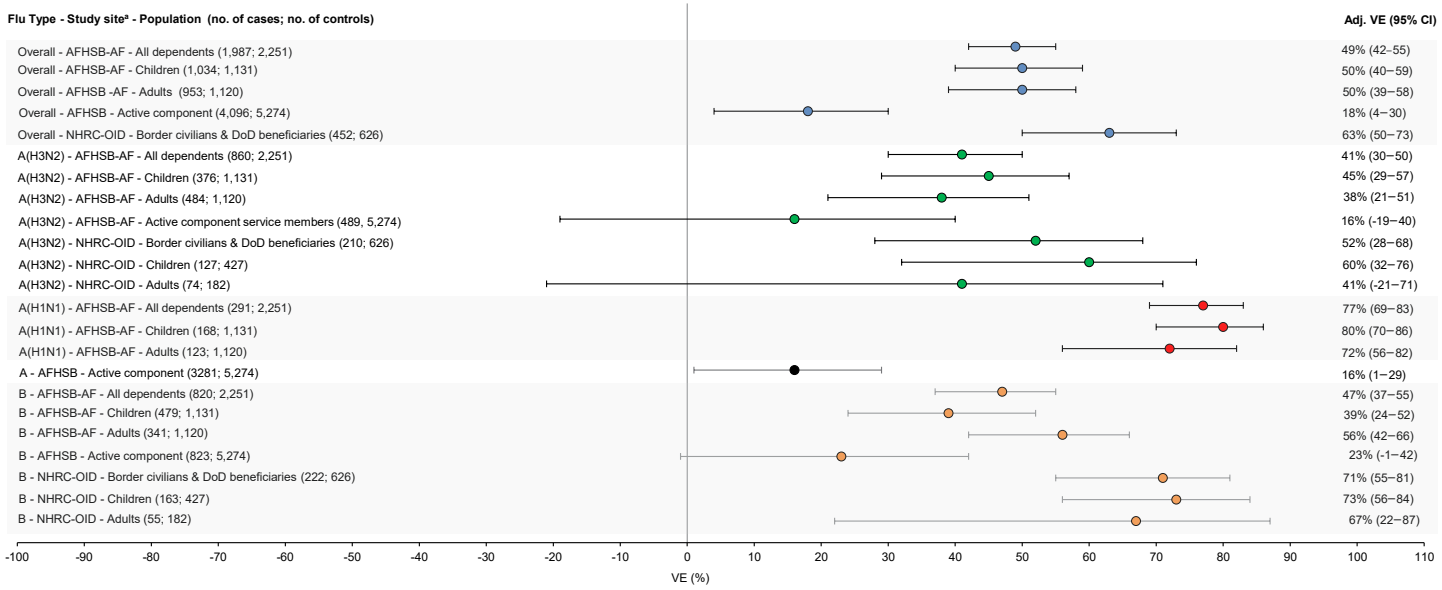
NHRC-OID's VE analysis consisted of 452 cases of whom 16% were vaccinated and 626 controls of whom 36% were vaccinated. The overall adjusted VE was moderate to high at 63% (95% CI: 50–73). Influenza A(H3N2) adjusted VE was moderate at 52% (95% CI: 28–68) and influenza B adjusted VE was high at 71% (95% CI: 55–81). Adjusted VE estimates for influenza A(H3N2) were higher among children at 60% compared with adults at 41%, although the VE for adults was not significantly different from zero. **(Table 2, Figure).**

AFHSB's VE analysis included 4,096 cases and 5,274 controls, with 91% and 93% being vaccinated, respectively. Overall, the adjusted VE for any influenza type was low at 18% (95% CI: 4–30). The adjusted VE for influenza A (any subtype) was also low at 16% (95% CI: 1–29). For influenza A(H3N2) and influenza B, the adjusted VE estimates were low and were not statistically significantly different from zero at 16% (95% CI: -19–40) and 23% (95% CI: -1–42), respectively **(Table 3, Figure).**

EDITORIAL COMMENT

Overall adjusted VE estimates varied by study population, ranging from moderate-high among AFHSB-AF non-service member DoD beneficiaries and NHRC-OID border populations (non-service member) to low among active component service members in the AFHSB analysis.

FIGURE. Department of Defense end-of-season influenza vaccine effectiveness (VE), 2017–2018



CI, confidence interval; AFHSB-AF, Armed Forces Health Surveillance Branch–Air Force Satellite; AFHSB, Armed Forces Health Surveillance Branch; NHRC-OID, Naval Health Research Center Operational Infectious Disease Directorate.
[a]For AFHSB-AF: Total no. of cases in overall analyses included unsubtyped influenza and dual influenza co-infections. Subtype analyses did not include these cases.
VE markers: Overall (*blue*); A(H3N3) (*green*); A(H1N1) (*red*); A un-subtyped (*black*); B (*yellow*).

As expected, the end-of-season VE estimates were similar to those reported from the DoD 2017–2018 midseason VE analyses, but with increased precision demonstrated by narrower confidence intervals from larger sample sizes. The larger sample sizes also allowed for subtype analyses for each study site.

Each of the VE analyses had several limitations. First, because influenza vaccination is mandatory for service members, both cases and controls had high vaccination rates in the AFHSB analysis. These high vaccination rates may negatively impact VE estimates in this population due to methodologic validity (i.e., limited availability of unvaccinated controls) and biologic effects of repeated vaccination.[1] In addition, service members are typically younger, healthier and more highly vaccinated than the general population limiting the generalizability of the current results to other populations. Second, less severe cases may not have been included in the analyses as individuals had to be sick enough to seek care at a medical facility and/or meet the site-specific ILI case definition. Third, small sample sizes for the elderly population (aged 65 years or older) did not allow for the estimation of VE for this subpopulation who are at higher risk for influenza complications. Finally, certain sub-analyses had small cell counts so there was insufficient power to calculate adjusted VE estimates.

The public health impact of the influenza vaccine on the general U.S. population during the 2017–2018 season is unknown as the CDC has not yet published its end-of-season influenza VE estimates. However, during the 2016–2017 influenza season, with an overall VE estimate of 40%, it is estimated that the vaccine prevented over 5.2 million illnesses, 2.5 million medical visits, and nearly 85,000 influenza-associated hospitalizations.[1] Given that the 2017–2018 season appears to be more severe based upon key metrics, even a moderate VE for the 2017–2018 season would be expected to have an even greater public health impact, particularly for DoD populations. As nearly all service members are vaccinated, a moderate VE for the 2017–2018 influenza season could greatly reduce illness from influenza infection. This reduction in illness would likely result in fewer lost-duty days, allowing service members to continue achieving mission objectives. Furthermore, financial savings and decreased strain on the healthcare system of the DoD might aid in achieving operational military readiness. Assessing vaccine effectiveness each season among DoD populations will continue to be important as circulating strains change and new vaccines become available. Given the updated recommendations for the quadrivalent live attenuated influenza vaccine (LAIV4)[5] and the emergence of cell-derived and recombinant influenza vaccines, ongoing evaluation of influenza VE is crucial to ensure that DoD is providing its populations with the most effective influenza vaccines. This report highlights the continued need to perform robust and diverse influenza surveillance and VE analyses each season and the importance of selecting accurate influenza vaccine components each season to positively impact public health for the DoD, reducing morbidity and mortality. This is critical to the DoD population to carry out and accomplish key missions of the U.S. military.

Author affiliations: Defense Health Agency/ Armed Forces Health Surveillance Branch Air Force Satellite–USAFSAM, *Wright-Patterson AFB, OH (Mr. Coleman, Ms. DeMarcus, Lt Col Federinko); Oak Ridge Institute for Science and Education, Oak Ridge, TN (Mr. Coleman); STS Systems Integration, LLC, San Antonio, TX (Ms. Demarcus); Armed Forces Health Surveillance Branch, Silver Spring, MD (Dr. Eick-Cost, Ms. Zheng Hu, Ms. Lynch); Operational Infectious Disease Directorate, Naval Health Research Center, San Diego, CA (Dr. Myers); The Henry M. Jackson Foundation for the Advancement of Military Medicine, Inc., Bethesda, MD (Mr. Hawksworth).*

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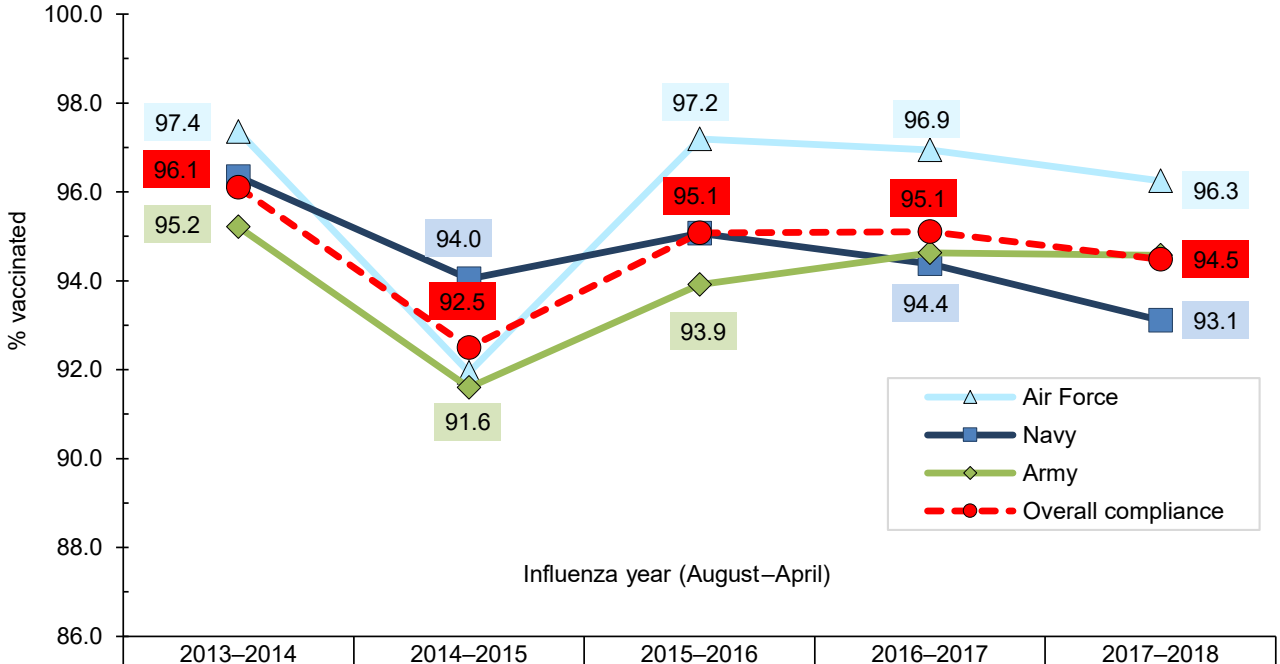
Notice to Readers

The September 2018 issue of the *MSMR* reported on human papilloma virus (HPV) vaccination initiation and completion rates in active component service members aged 26 years and younger. On October 5, 2018, the U.S. Food and Drug Administration expanded the approved use of the nine-valent HPV vaccine (Gardasil®9) to include women and men aged 27–45 years. Gardasil®9 has been shown to prevent cancers and other diseases caused by the nine types of HPV covered by the vaccine: 6, 11, 16, 18, 31, 33, 45, 52, and 58.

The original September 2018 report offers continuing education (CE) and continuing medical education (CME) credit to qualified professionals, as well as a certificate of participation to those desiring documentation. For more information, go to www.health.mil/msmrce.

Surveillance Snapshot: Influenza Immunization Among U.S. Armed Forces Healthcare Workers, August 2013–April 2018

FIGURE. Percentage of healthcare specialists and officers with records of influenza vaccination, by influenza year (1 August through 30 April) and service, active component, U.S. Armed Forces, August 2013–April 2018



	2013–2014	2014–2015	2015–2016	2016–2017	2017–2018
Air Force	97.4	91.9	97.2	96.9	96.3
Navy	96.3	94.0	95.1	94.4	93.1
Army	95.2	91.6	93.9	94.6	94.6
Overall compliance	96.1	92.5	95.1	95.1	94.5

The U.S. Advisory Committee on Immunization Practices recommends that all healthcare personnel be vaccinated against influenza to protect themselves and their patients.[1] The Joint Commission's standard on infection control emphasizes that individuals who are infected with influenza virus are contagious to others before any signs or symptoms appear. The Joint Commission requires that healthcare organizations have influenza vaccination programs for practitioners and staff, and that they work toward the goal of 90% receipt of influenza vaccine. Within the Department of Defense, seasonal influenza immunization is mandatory for all uniformed personnel and for healthcare personnel who provide direct patient care, and is recommended for all others (excluding those who are medically exempt).[2-4] This snapshot covers a 5-year surveillance period (August 2013–April 2018) and presents the documented percentage compliance with the influenza immunization requirement among active component healthcare personnel of the Army, Navy, and Air Force. During the 2017–2018 influenza season, each of the three services attained greater than 93% compliance among healthcare personnel **(Figure)**. For all services together, the compliance rate was 94.5%. This rate represents a very slight decrease in the overall immunization rate compared to the previous year.

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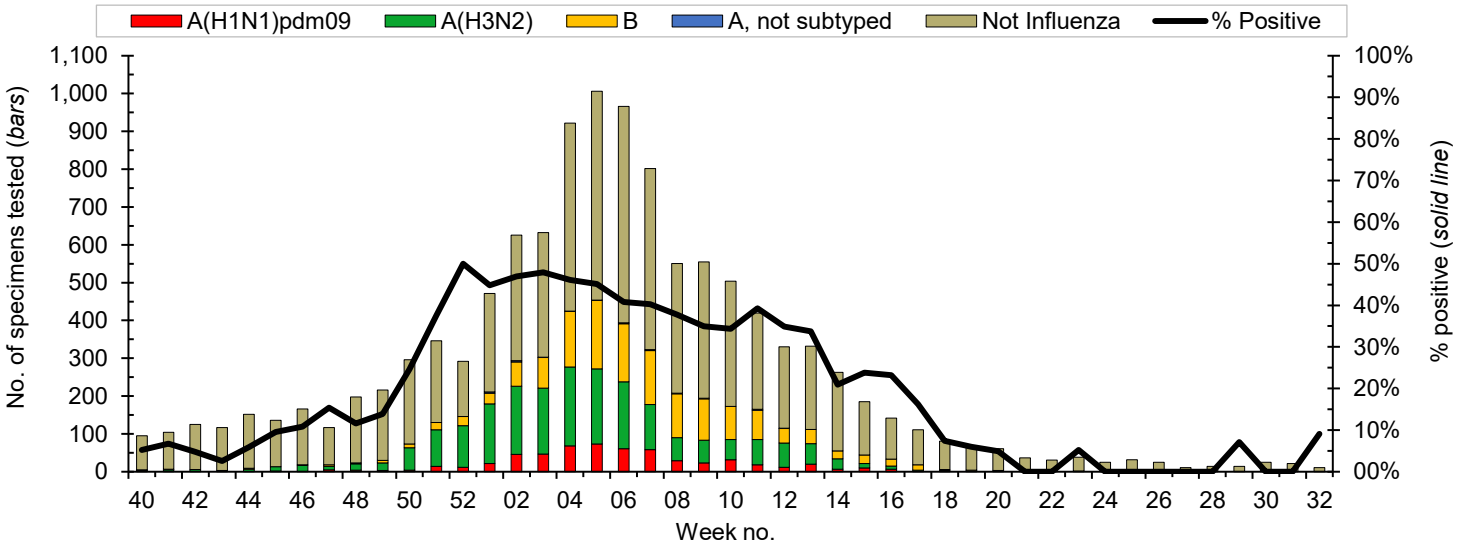
Surveillance Snapshot: Summary of the Department of Defense Global Respiratory Pathogen Surveillance Program, 2017–2018 Influenza Season

Lisa A. Shoubaki, MPH

FIGURE. Numbers and percentages of respiratory specimens positive for influenza viruses, and numbers of influenza and non-influenza pathogens identified, by type, by surveillance week, 2017–2018 influenza season



The Department of Defense Global Respiratory Pathogen Surveillance Program (DoDGRS) performs annual influenza surveillance to track incidence trends and provides data to the Centers for Disease Control and Prevention and other partners for vaccine strain selection. A larger than usual number of specimens was submitted for laboratory testing during the 2017–2018 influenza season, which resulted in a robust set of results for viruses from both Northern and European Commands. DoDGRS, a sentinel site-based program, requests that each site submit six to 10 specimens weekly with patient questionnaires from individuals who meet the influenza-like illness (ILI) case definition. ILI is defined as the presence of fever (>100.5°F) and either cough or sore throat within 72 hours of symptom onset. Additional program information has been described in previously published articles.[1]

During the 2017–2018 influenza season, a total of 11,692 specimens were tested from 98 locations. Among these specimens, 1,800 (15.4%) tested positive for influenza A(H3N2); 538 (4.6%) were positive for influenza A(H1N1)pdm09; 19 (0.2%) were positive for influenza A/not subtyped; 1,313 (11.2%) were positive for influenza B; 369 (3.2%) were positive for influenza co-infections; 3,746 (32.0%) were positive for other respiratory pathogens; and 3,907 (33.4%) were negative. The most common respiratory pathogen was rhinovirus/enterovirus (n=1,209). Other common respiratory pathogens included coronavirus (n=638), respiratory syncytial virus (n=546), human metapneumovirus (n=425), and parainfluenza (n=239). Peak influenza activity occurred during weeks 51 through 14 (17 December 2017 through 7 April 2018). The predominant influenza strain this season was A(H3N2) with influenza B increasing during the peak weeks. About 72% of the specimens were tested at U.S. Air Force School of Aerospace Medicine, and about 22% of specimens were tested at Landstuhl Regional Medical Center. It is noteworthy that, during the early months of the season, isolates of influenza B virus predominated in the European Command but influenza A(H3N2) virus predominated in the Northern Command.

Author affiliations: STS Systems Integration, LLC; Air Force Satellite Cell of the Armed Forces Health Surveillance Branch, Defense Health Agency, Wright-Patterson Air Force Base, OH.

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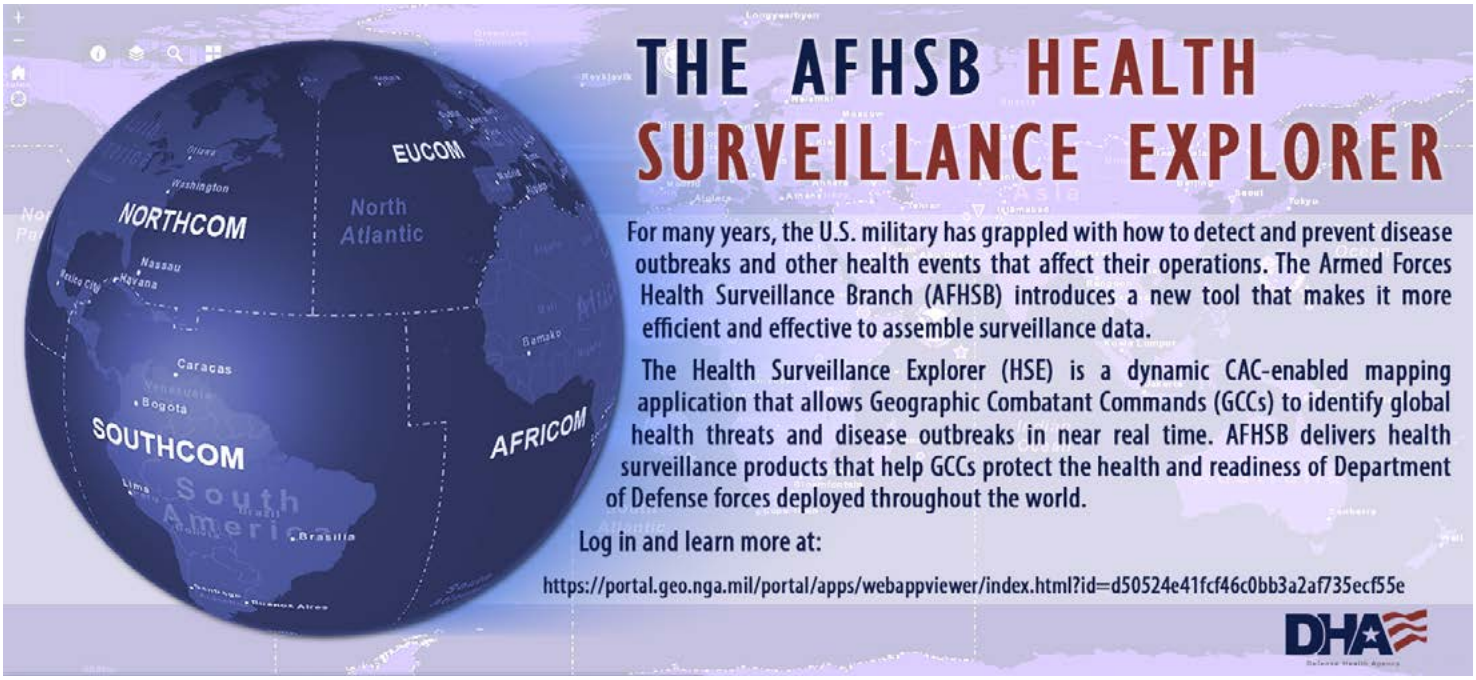

THE AFHSB HEALTH SURVEILLANCE EXPLORER

For many years, the U.S. military has grappled with how to detect and prevent disease outbreaks and other health events that affect their operations. The Armed Forces Health Surveillance Branch (AFHSB) introduces a new tool that makes it more efficient and effective to assemble surveillance data.

The Health Surveillance Explorer (HSE) is a dynamic CAC-enabled mapping application that allows Geographic Combatant Commands (GCCs) to identify global health threats and disease outbreaks in near real time. AFHSB delivers health surveillance products that help GCCs protect the health and readiness of Department of Defense forces deployed throughout the world.

Log in and learn more at:

https://portal.geo.nga.mil/portal/apps/webappviewer/index.html?id=d50524e41fcf46c0bb3a2af735ecf55e

DHA

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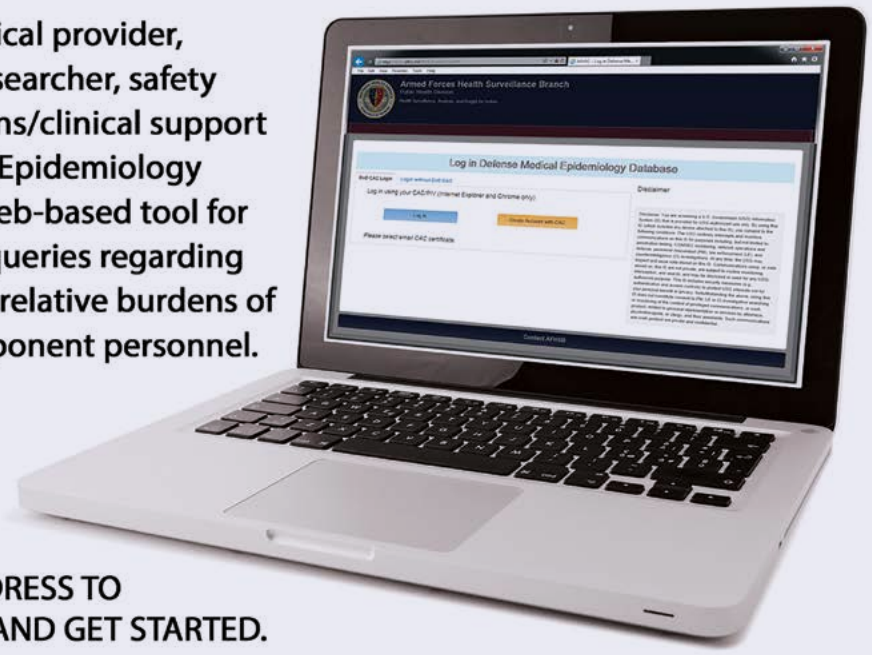
Are you a U.S. military medical provider, epidemiologist, medical researcher, safety officer, or medical operations/clinical support staff? The Defense Medical Epidemiology Database (DMED) is your web-based tool for remote access to perform queries regarding illness and injury rates and relative burdens of disease among active component personnel.



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CONFIRM YOUR EMAIL ADDRESS TO COMPLETE REGISTRATION AND GET STARTED.

Medical Surveillance Monthly Report (MSMR)
Armed Forces Health Surveillance Branch
11800 Tech Road, Suite 220
Silver Spring, MD 20904

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