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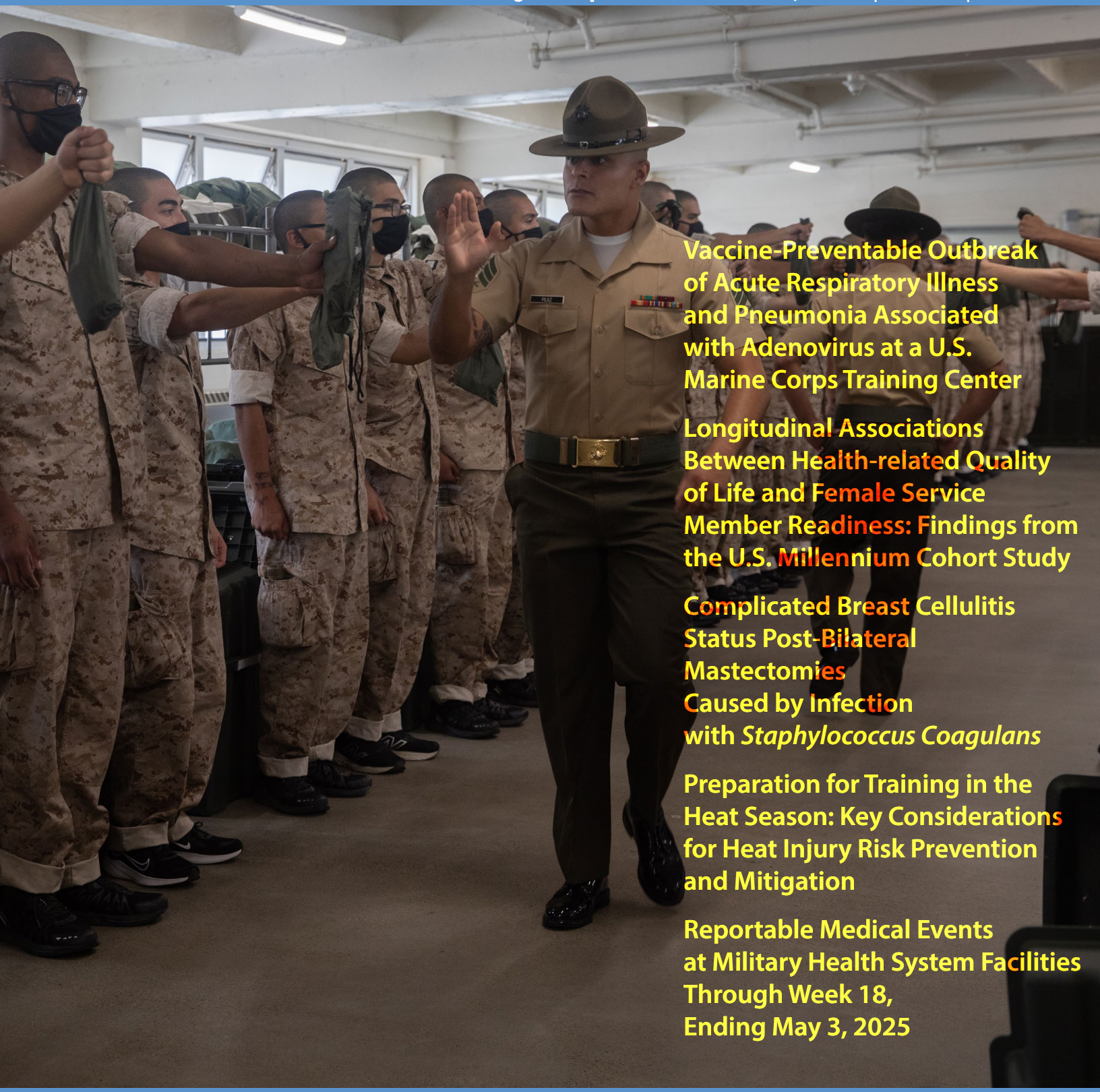

Vaccine-Preventable Outbreak of Acute Respiratory Illness and Pneumonia Associated with Adenovirus at a U.S. Marine Corps Training Center

Longitudinal Associations Between Health-related Quality of Life and Female Service Member Readiness: Findings from the U.S. Millennium Cohort Study

Complicated Breast Cellulitis Status Post-Bilateral Mastectomies Caused by Infection with *Staphylococcus Coagulans*

Preparation for Training in the Heat Season: Key Considerations for Heat Injury Risk Prevention and Mitigation

Reportable Medical Events at Military Health System Facilities Through Week 18, Ending May 3, 2025

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Medical Surveillance for Military Readiness

Table of Contents

Outbreak Report

Vaccine-Preventable Outbreak of Acute Respiratory Illness and Pneumonia Associated with Adenovirus at a U.S. Marine Corps Training Center

Lynn A. Van Airsdale, DO, MPH; Jacqueline M. Peretti, MD, MPH; Asha J. Riegodedios, MSPH; Aliye Z. Sanou, DO, MPH; Lisa A. Pearse, MD, MPH

Adenovirus outbreaks have long been a cause of acute respiratory disease, hospitalization, and death in otherwise young, healthy military recruits. The administration of oral, live attenuated adenovirus (AdV) vaccine against AdV types 4 and 7 has been critical in preventing outbreaks in this population.[1-4] In early July 2024, a spike in recruit hospitalizations for AdV pneumonia was recognized at the Marine Corps Recruit Depot (MCRD) San Diego, and an outbreak investigation commenced. From July 1 through September 23, 2024, a total of 212 AdV cases, including 28 hospitalizations, were identified among trainees and staff. Non-pharmaceutical interventions, including aggressive environmental cleaning, separation of sick and well recruits, and masking, were implemented. The outbreak was not appreciably slowed, however, until AdV vaccine administration was advanced from day 11 to day 1 post-arrival of recruits to MCRD San Diego. This outbreak report demonstrates that early AdV vaccination for newly arriving recruits is an effective and essential step in preventing AdV morbidity and mortality in a recruit training setting.

What are the new findings?

Despite the availability and widespread use of effective vaccines during recruit training, adenovirus outbreaks remain a significant threat to military recruits if the vaccine is not administered expediently, upon arrival to the recruit training center.

What is the impact on readiness and force health protection?

Adenovirus outbreaks can occur in military recruit environments when vaccination is not accomplished promptly after arrival. Recruit vaccination prior to, or very soon after, arrival to a military recruit setting minimizes the impacts of adenovirus by preventing disease outbreaks, medical separations, and training disruption.

Military recruit populations are uniquely susceptible to acute respiratory disease (ARD) outbreaks due to the rapid introduction of large numbers of people from a broad geographic catchment area into crowded, congregate, and high stress living conditions.[3] Historical studies of ARD show that up to 80% of febrile ARD cases in recruits are due to adenovirus (AdV), with 20% resulting in hospitalization.[5] Serotypes 4 and 7 were most common, repeatedly resulting in military recruit outbreaks.[6]

As a result of high rates of morbidity and disruption of recruit training, the U.S. military developed and implemented a live, oral vaccine against AdV serotypes 4 and 7 starting in the 1970s, through the 1990s, that successfully reduced respiratory illnesses.[7] Febrile respiratory illness in vaccinated recruit training sites decreased by 50% and AdV infection decreased by more than 90%.[3,4,8,9]

Vaccine production was halted by the sole manufacturer in 1995 and total depletion of AdV vaccine supply occurred in 1999. Between 1999 and 2011, multiple large outbreaks of AdV resurfaced in recruit training centers across the U.S.,[10-13] resulting in 8 deaths associated with AdV infection.[1] AdV vaccine was reintroduced to the recruit population in 2011, proving to be 99.3% effective, and within 2 years there was a 100-fold decline in AdV disease burden.[14] Sporadic outbreaks have subsequently occurred, primarily affecting populations where adenovirus vaccine is not routinely administered.[15-17]

At Marine Corps Recruit Depot (MCRD) San Diego, new recruits arrive weekly and are placed into platoons that comprise companies. Companies then train together for a 12-week training cycle. MCRD's staggered training cycle maximizes training efficiency, and involves ongoing close contact, high density living environments, and potential exposure to, and spread of, infectious diseases. Prior to training commencement, recruits proceed through "receiving week," which begins day 1 post-arrival and includes a medical portion for laboratory testing of vaccine titers, G6PD (glucose-6-phosphate dehydrogenase) status, blood typing, gonorrhea and chlamydia testing, HIV and hepatitis screening, and universal pregnancy testing for female recruits. To avoid exposing pregnant and separating recruits to live vaccines, vaccines were historically administered day 11 post-arrival, after all laboratory results were received.

In early July 2024, local military public health assets were alerted to a spike

in hospitalized AdV pneumonia cases of MCRD San Diego recruits. This triggered an outbreak investigation to identify the reason for the increased number of cases and to implement mitigation measures. This report describes the investigation and findings of a major outbreak of AdV since the re-introduction of the AdV vaccine in 2011.

Methods

In early July 2024, MCRD San Diego experienced 9 hospitalized AdV pneumonia cases within a 2-week period, accompanied by a notable increase in outpatient ARD cases. An outbreak investigation was initiated on July 16. A case was defined as an outpatient or inpatient MCRD San Diego recruit or training site staff member with AdV detected on multiplex respiratory pathogen PCR (polymerase chain reaction; BIOFIRE Respiratory 2.1) on or after July 1, 2024.

A line listing of cases was maintained in Microsoft Excel and managed in Microsoft Teams (with access controlled) to promote transparency within the outbreak response team. The Military Health System Electronic Health Record–Generation Next (MHS GENESIS) and Naval Medical Center San Diego (NMCSD) Nurse of the Day report were used to populate the line list data, including demographics (e.g., recruit or staff, age, sex, training date, company), AdV vaccination date, date of symptom onset, date of first clinical visit, hospitalization status including date of admission and discharge, pneumonia diagnosis, AdV laboratory result, and other co-infections. Other co-infections were determined on the same multiplex respiratory pathogen PCR that detected AdV.

Due to delays in seeking care, particularly at the beginning of the outbreak, epidemiological curves were created based on date of symptom onset as well as date of initial clinic visit. Although the case definition represents those testing positive on or after July 1, the symptom onset of cases with positive laboratory tests dated back to as early as June 10, which is when this outbreak surveillance period began.

Illness severity was monitored based on hospitalization status, number of days hospitalized, and need for repeated hospitalization. Attack rates by company were calculated using company population estimates from the beginning of each training cohort.

Vaccination and symptom onset association was calculated using the vaccine administration date and symptom onset date. Vaccine protection analysis compared the rates of AdV between non-immune—defined as unvaccinated or within 14 days post-vaccination—and immune individuals—defined as symptom onset more than 14 days post-vaccination. This was calculated based on crude attack rates among selected recruit companies (Charlie, Fox, Lima, Bravo, Echo, India, Delta) who had similar chances of exposure (e.g., started training after the outbreak began and before acceleration of the vaccine schedule), representing a total of 4,500 recruits.

The end of the outbreak was defined as 28 days, or 2 maximum incubation periods, after the last symptomatic patient that resulted in an inpatient admission, and outpatient AdV case counts that remained below baseline. Baseline outpatient AdV case counts were determined through evaluation of historic records from the Discern Reporting Portal in MHS GENESIS to be 2 cases per 7-day timeframe.

Results

The epidemiological curve, based on symptom onset, demonstrated a propagated source outbreak that occurred from June 10 to September 15 **(Figure 1)**. A total of 212 AdV cases from MCRD San Diego were identified. Twenty-eight of the MCRD San Diego AdV cases required hospital admission, and 3 required ICU admission. There were no fatalities. Recruits accounted for 96.7% of the AdV outbreak cases, with the remainder in staff members **(Table 1)**. A majority of the AdV cases also tested positive for other infectious etiologies, such as rhinovirus/enterovirus, seasonal coronaviruses, COVID-19, parainfluenza, H. metapneumovirus, influenza A and B, group A *Streptococcus*, and *M. pneumoniae*.

Attack rates, by company and date of arrival to recruit training, are shown in **Figure 2**. The outbreak affected 7 companies, with an average rate of illness of 3.6% per company. The company with the highest rate (6.8%) of illness arrived at MCRD San Diego during the week of July 8. Average length of time from AdV vaccination to date of symptom onset was 1 day **(Table 1)**.

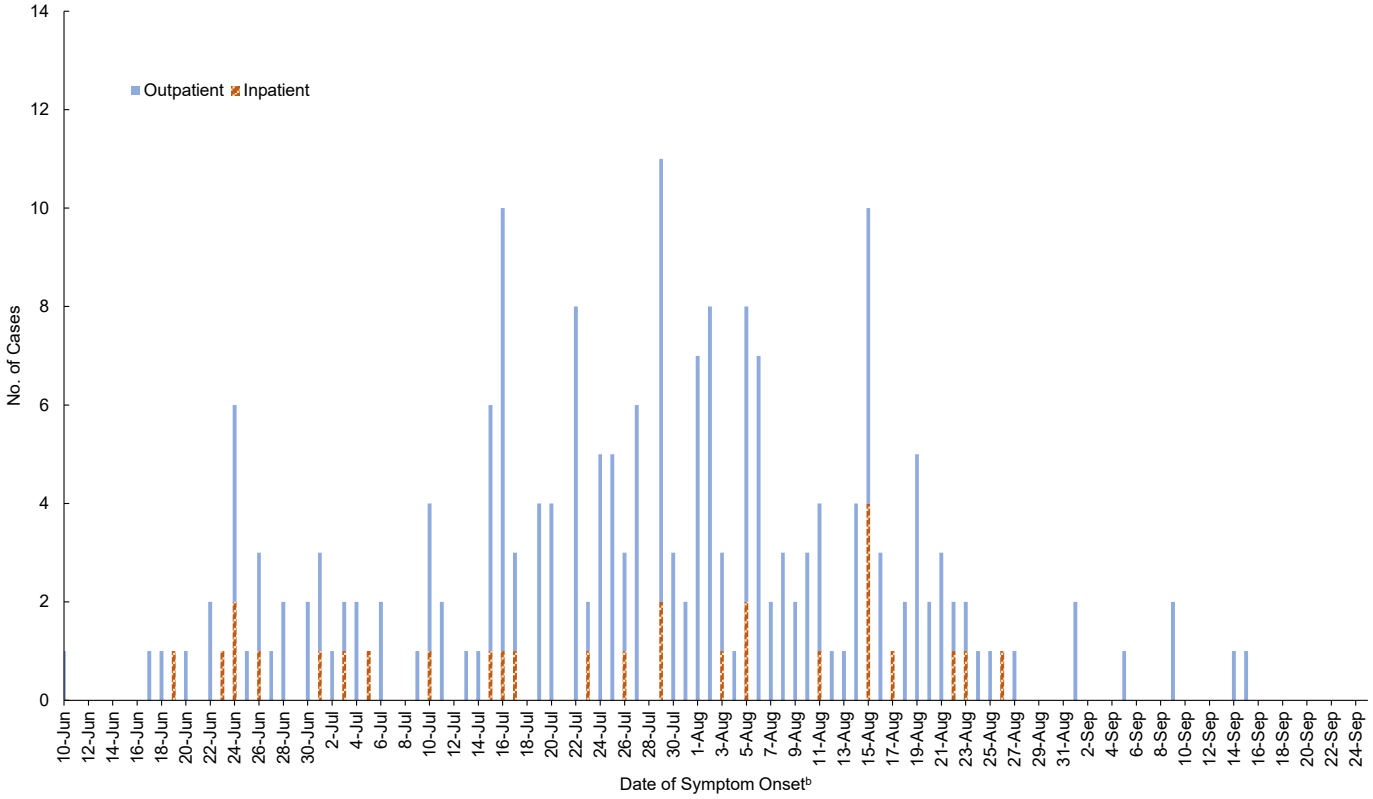
The AdV vaccination schedule was accelerated on August 14. The first company to receive the vaccination day 1 post-arrival exhibited an attack rate of 0.95%, a 4-fold decrease compared to the average of the previous 7 companies. Ultimately, the overall attack rate of AdV among non-immune individuals was 3.3%, compared with 0.1% for those who were considered immune, representing a 35.6-fold difference **(Table 2)**. While a few recruits developed AdV 14 days after vaccination, none required admission.

The average length of hospital stay (including re-admission time) was 8.6 days. As of February 28, 2025, 18 hospitalized recruits were returned to active duty as fit for full duty, and 10 recruits were separated for health reasons. The last AdV inpatient admission occurred on August 26, 2024. The end of the outbreak was declared on September 23, 2024, based on the criteria of 28 days after the last symptomatic patient with inpatient admission and outpatient adenovirus case counts remaining below baseline.

Discussion

Adenovirus, a vaccine-preventable disease, has historically led to significant morbidity, mortality, and training disruptions in U.S. military training sites.[5-7,18] MCRD San Diego experienced an introduction of AdV in June 2024 that opportunistically spread through an under-vaccinated population of recruits during the 26-day period from recruit arrival to full AdV protection, defined as 14 days post-vaccination. The virus spread readily between the training companies, introduced into new companies as they arrived, until vaccine administration was advanced to day 1 post-arrival at the training center.

FIGURE 1. Distribution of Adenovirus Cases by Symptom Onset Date and Patient Status (n=210)[a]



Abbreviations: n, number; No., number; Jun, June; Jul, July; Aug, August; Sep, September.
[a] Two outpatients had undocumented symptom onset dates.
[b] While the case definition represents those testing positive after July 1, symptom onsets date to June 10 because cases early in the outbreak were characterized with significant delays in clinic presentation and testing. The June 10 case was part of a cohort with several cases that became symptomatic later in June, creating a plausible epidemiological link. It is unclear whether this case represents the index case.

Upon discovery of the AdV outbreak, preventive medicine and public health entities rapidly engaged with the MCRD clinic, as well as recruit training staff, drill instructors, and MCRD dining hall staff, to communicate disease education and environmental risk recommendations. Nonpharmaceutical interventions—including enhanced hygiene and disinfection protocols, increased emphasis on hand hygiene, segregation of ill recruits, improved berthing air circulation, and food service modifications to halt self-service—were quickly introduced. Weekly habitability inspections were conducted by public health personnel, to reinforce the recommendations. Despite these interventions, the outbreak continued to spread.

Early in the outbreak it was noted that AdV vaccination was being administered day 11 post-arrival, to allow for pregnancy testing of accessioning females, in addition to assessment of vaccine titers. A joint Department of Defense (DOD) regulation, *Immunizations and Chemoprophylaxis for the Prevention of Infectious Diseases*,[19] prescribes immunizations for prevention of infectious diseases and provides general principles, procedures, policies, and responsibilities but does not dictate precise vaccination schedules. Implementation of the regulation varies among military training sites, with most training sites administering AdV vaccine by day 6 post-arrival.

After reviewing other training sites' vaccine timing schedules and determining time required for complete immunity, the preventive medicine and public health entities involved in this outbreak response recommended shifting AdV vaccine administration, along with other standard vaccines, from day 11 to day 1 post-arrival. This became a top priority for outbreak control. On August 14, the AdV vaccination schedule was advanced to day 1 post-arrival.

While the concern of vaccinating women with a live virus vaccine is legitimate, pregnancy testing is not required by instruction in DOD nor U.S. Navy policy.[19] Although, to date, there have been no documented adverse pregnancy outcomes due to AdV vaccination, there is a theoretical risk to the fetus with live vaccine administration, thus live vaccines are a general contraindication during pregnancy.[20-22]

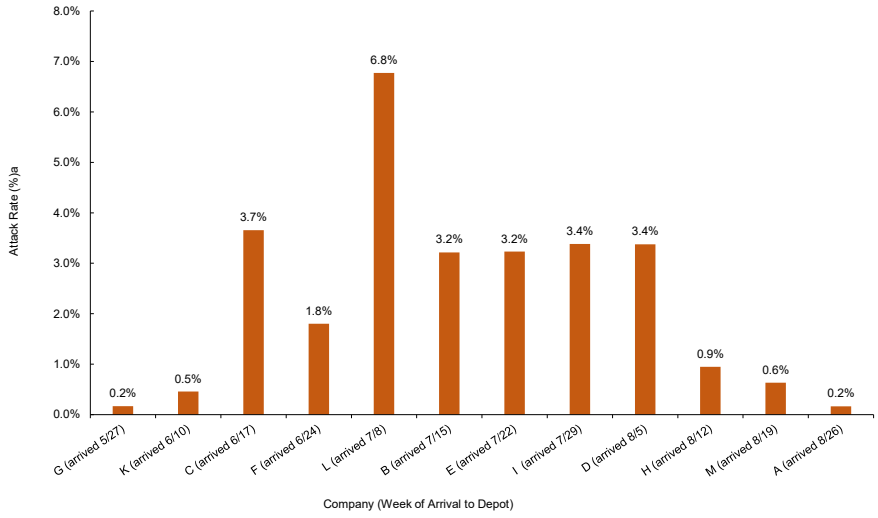
Two weeks after initiation of the expedited vaccine schedule, overall incidence was rapidly declining. At that time, it was found that the majority of new infections were in recruits who had missed the initial AdV vaccination day and received no AdV vaccine. Once this was discovered, the medical team at MCRD identified those recruits, who had been removed from training but remained on base for medical reasons or for administrative separation, and ensured vaccination completion in this population.

TABLE 1. Distribution of Adenovirus Cases by Selected Factors

Factor	Cases	Total
	No.	%
Status		
Recruit	205	96.7
Staff	7	3.3
Sex		
Female	18	8.5
Male	194	91.5
Severity indicators		
Pneumonia	79	37.3
Inpatients	28	13.2
ICU (out of all inpatients)	3	10.7
Re-admitted (out of all inpatients)	6	21.4
Number of days in hospital (average)	8.6 days	
Hospitalization rate	13.2 (%)	
Additional laboratory-specific etiologies		
Rhinovirus / enterovirus detected	123	58
COVID-19 / SARS-CoV-2 detected	38	17.9
Other etiologies detected	158	74.5
Average time from vaccination date to symptom onset date[a]		
All cases	0.9 days (SD 9.4 days)	
Outpatients	1.1 days (SD 8.5 days)	
Inpatients	-0.4 days (SD 6.4 days)	

Abbreviations: No., number; ICU, intensive care unit; COVID-19, coronavirus disease 2019; SARS-CoV-2, severe acute respiratory syndrome coronavirus 2; SD, standard deviation.
[a] Calculation includes only recruits in training; recruit center staff and recruits dropping to 'holding' company not included.

FIGURE 2. Attack Rates[a] of Adenovirus Illness During the Adenovirus Outbreak at Marine Corps Recruit Depot San Diego, by Company, June–September 2024



[a] Number of recruits sick divided by total number of recruits in company.

Interestingly, nearly 75% of cases had co-infections with other respiratory pathogens, most notably seasonal coronaviruses, COVID-19, and rhinovirus / enterovirus. This finding suggests that infection with AdV may increase susceptibility to other viruses, although more research is needed to better interpret this finding, which has not been identified in previous AdV outbreaks. Newly increased testing sensitivity associated with multiplex respiratory pathogen PCR availability may have been a factor in co-infection identification during this outbreak.

The key intervention for ending this AdV outbreak was advancing the AdV vaccine to the earliest possible date for newly arriving recruits, in addition to ensuring any recruit remaining on station (including those anticipating separation) were vaccinated. Average time from vaccination date to symptom onset date among AdV cases in training was 0.9 days (SD 9.4 days). Of note, early symptoms of AdV may be very mild, and some individuals were likely already symptomatic with unrecognized AdV when vaccinated, and most cases became symptomatic before the 14 days required to have reached full vaccine effectiveness. Inpatients appeared more likely to have received vaccine while symptomatic, but the clinical significance of receiving vaccine after infection with AdV is beyond the scope of this report. While there was initial question about decreased vaccine effectiveness with this particular AdV strain, the rapid decrease in attack rates, shown in **Table 2**, and outbreak resolution upon implementation of the accelerated vaccination schedule, strongly suggest that the circulating strains of AdV remained covered by the current AdV vaccine (Adenovirus Type 4 and Type7 Vaccine, Live, Oral).

A strength of the study included the availability of multiplex respiratory pathogen PCR for rapid diagnosis of cases. Tracking of cases using Microsoft Excel, MHS GENESIS, and Microsoft Teams, for efficient and secure collection of data and collaboration between MCRD San Diego, NMCSD Preventive Medicine, Navy Environmental and Preventive Medicine Unit FIVE, and the Epi Data Center from the Navy Marine Corps Force Health Protection Command allowed for accurate

TABLE 2. Risk of Illness Among Non-Immune and Immune Recruits Prior to Advanced Vaccine Schedule

Case and Immunity[a] Status	Cases	Attack Rate[b]	Risk Ratio
	No.	%	
All cases			
Non-immune	147	3.3	35.6
Immune	4	0.1	
Outpatients only			
Non-immune	128	2.8	31.0
Immune	4	0.1	
Inpatients only			
Non-immune	19	0.4	—
Immune	0	0	

Abbreviations: No., number; n, number.
[a] Non-immune indicates symptom onset before vaccination through day 14 post-vaccination. Immune indicates symptom onset after 14 days post-vaccination.
[b] The estimated susceptible recruit population (n=4,500) was used to determine the attack rate among cases with non-immunity; non-immune cases were excluded from the susceptible population (n=4,353) to estimate attack rates for cases with immunity.

and efficient expert consultation. Other strengths included the ability to identify vaccination timing and the results of accelerating the AdV vaccine schedule.

Limitations of this study include the delay in case identification, likely underestimation of case numbers, and data limitations on calculating vaccine effectiveness based on person-time. The outbreak was characterized by mild symptoms at illness onset, leading to delays in care seeking and laboratory testing, particularly at the beginning of the outbreak when laboratory testing was potentially not conducted, unless warranted due to pneumonia concerns. The delay in case identification introduced challenges for monitoring outbreak progression and measuring intervention effectiveness. To mitigate this, we analyzed data using both symptom onset and clinic visit dates, using symptom onset date for the epidemiological curve; however, our data could not be used to calculate vaccine effectiveness based on person-time. Despite these gaps in case capture and person-time analysis, vaccination was clearly crucial in controlling the outbreak, preventing severe disease casualties, and preserving the training schedule.

This outbreak demonstrated, despite availability and widespread use of effective vaccines during recruit training, that AdV remains a significant medical threat to military recruits when the vaccine is not administered expeditiously, upon arrival to a recruit training center. Early vaccination should remain a central tenet for prevention and control of communicable diseases in these high risk, congregate settings.

Author Affiliations
Navy Environmental and Preventive Medicine Unit (NEPMU) FIVE, San Diego, CA: LCDR Van Airsdale, LCDR Peretti; Navy Marine Corps Force Health Protection Command (NMCFHPC), Portsmouth, VA: CDR Sanou, Ms. Riegodedios, Dr. Pearse

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Disclaimers
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Brief Report

Longitudinal Associations Between Health-related Quality of Life and Female Service Member Readiness: Findings from the U.S. Millennium Cohort Study

Isabel G. Jacobson, MPH; Sheila F. Castañeda, PhD; Yunnuo Zhu, MPH; Crystal L. Lewis, EdD; Felicia R. Carey, PhD

The expansion of service women's occupational roles in the U.S. military has heightened focus on women's health, with the Department of Defense recently committing to "spending half a billion dollars each year on women's health research."[1] These efforts could benefit from a comprehensive understanding of readiness among service women. Medical readiness may be broadly considered as the capability to achieve military mission and job success.[2] Given that readiness is multi-factorial and requires physical and mental fitness, measurable markers such as body mass index (BMI) and lost work days, while not exhaustive measures, are important to consider.

Body composition standards have been in place in the military for many decades[3] to ensure personnel readiness.[4] BMI is indirectly associated with retention in the military, as those who fail to meet weight standards are often separated from service. Although BMI cannot distinguish between fat and fat-free mass, a meta-analysis showed that BMI had a sensitivity of 51% and a specificity of 95% in women, suggesting that BMI performs well in correctly identifying those without obesity.[5] While those data also suggest that BMI is less accurate at identifying those with obesity, it may still offer utility as an initial screening for readiness, given its fast and non-invasive characteristics. Lost work days can also serve as an indicator of readiness, due to the rigors of military service, including deployments, posing frequent risks for injury, illness, or hospitalization,[6] leaving service members unable to perform their duties. Excessive lost work days may challenge mission completion and readiness.

Behavioral factors that may impede readiness include unhealthy sleep[7] and substance use; but screening for these factors may be cumbersome in fast-paced military environments. Measuring health-related quality of life (HRQOL)—or how mental, emotional, and physical capabilities affect daily functioning[8]—could provide a brief, non-intrusive screening tool for health-related factors associated with readiness. While HRQOL has been evaluated as a predictor of health outcomes in service member and military spouse populations,[9,10] to our knowledge no studies have focused on U.S. service women. The aim of this analysis was to understand if HRQOL is significantly associated with subsequent readiness outcomes among active duty service women.

Methods

Data were from active duty service women enrolled in the U.S. Millennium Cohort Study, the largest and longest-running study of military personnel and veterans.[11] Participants from all branches of service and components were enrolled in 5 panels: in 2001, 2004, 2007, 2011, and 2020. Among 260,228 enrolled participants, 79,872 were service women.[11]

For this evaluation of baseline HRQOL and subsequent readiness outcomes, eligibility criteria included: enrollment in the first 4 panels (n=18,078 excluded from panel 5, as no follow-up survey was available for those participants at the time of this study); completion of the first follow-up survey (n=24,569 excluded who did not complete a follow-up survey); and serving on active duty at baseline and follow-up (n=16,426 excluded who were not on active duty at baseline; n=7,014 excluded who were not on active duty at follow-up). After application of all eligibility criteria, a total of 13,785 active duty service women were included in the study. HRQOL and covariates were reported at baseline, 2001-2011; readiness outcomes were assessed at first follow-up, 2004-2014.

Baseline HRQOL was coded from Veterans RAND 12 Item Short Form Survey (VR-12) summary scores using a validated scoring algorithm[8] to capture effects of somatic (PCS, or physical component summary) and emotional (MCS, or mental component summary) health problems on basic daily functioning, with higher scores indicating better HRQOL, and lower scores indicating worse HRQOL. The Veterans RAND 12 Item Health Survey was developed from the Veterans RAND 36 Item Health Survey, which was developed and modified from the original RAND version of the 36-item Health Survey version 1.0 (also known as MOS SF-36).[12]

MCS and PCS scores have normative values, with a mean of 50 and standard deviation of 10, to compare with other U.S. populations.[13] Scores were categorized into 3 groups, using the 15th and 85th centiles to demarcate the low and high scoring groups, which roughly approximated 1 standard deviation from the mean.[10] Readiness-related outcomes included self-reported BMI and lost work days due to illness or injury (excluding time for pregnancy and childbirth).

The BMI readiness-related outcome was calculated from self-reported height and weight, dichotomized as women with a BMI under 30 kg/m^2 (i.e., more likely to be ready), versus those with a BMI of 30 kg/m^2 or greater (i.e., having obesity, less likely to be ready). The missed work days readiness-related outcome was calculated using the self-reported number of days that women were unable to work or perform usual activities within the past 3 years due to illness or injury; they were asked to exclude work days lost for pregnancy

and childbirth. This outcome was dichotomized as those who missed 5 or fewer work days during the follow-up period (i.e., more likely to be ready) versus those who missed 6 or more days (i.e., less likely to be ready).

Socio-demographic and military covariates included age, marital status, race and ethnicity, pay grade, service branch, and enrollment panel. No collinearity was found when assessed among MCS and PCS scores and covariates, based on a variance inflation factor threshold of 4 or greater. Poisson regression models with robust error variance estimated prevalence ratios to assess the association between HRQOL and readiness outcomes, with adjustment for baseline covariates. All statistical analyses were conducted using SAS software version 9.4 (SAS Institute, Inc., Cary, NC). The study was approved by the Naval Health Research Center Institutional Review Board (NHRC.2000.0007).

Results

Most service women in this sample were younger than age 35 years at baseline, non-Hispanic White race or ethnicity, and enlisted, while a plurality were married, in the Air Force, and enrolled in panel 1 (in 2001). Women with MCS scores less than 40.2 and PCS scores less than 47.3 were in the lowest 15th centile; those scoring greater than 57.9 and 58.0, respectively, were in the top 15th centile. Most women reported not having obesity (86.9%) and missing 5 or fewer workdays (66.2%) due to illness or injury **(Table)**.

Adjusted multivariable models suggest that higher MCS and PCS scores were significantly associated with a higher likelihood for readiness, as defined by lack of obesity and fewer missed workdays **(Figure)**. Women scoring in the top 15th centile for PCS demonstrated higher adjusted prevalences of non-obese BMI (APR 1.8, 95% CI 1.5, 2.2) and 5 or fewer lost workdays (APR 1.4, 95% CI 1.2, 1.5) compared to women scoring in the middle 70th centile. Results were similar for MCS scores, but measures of association were slightly lower.

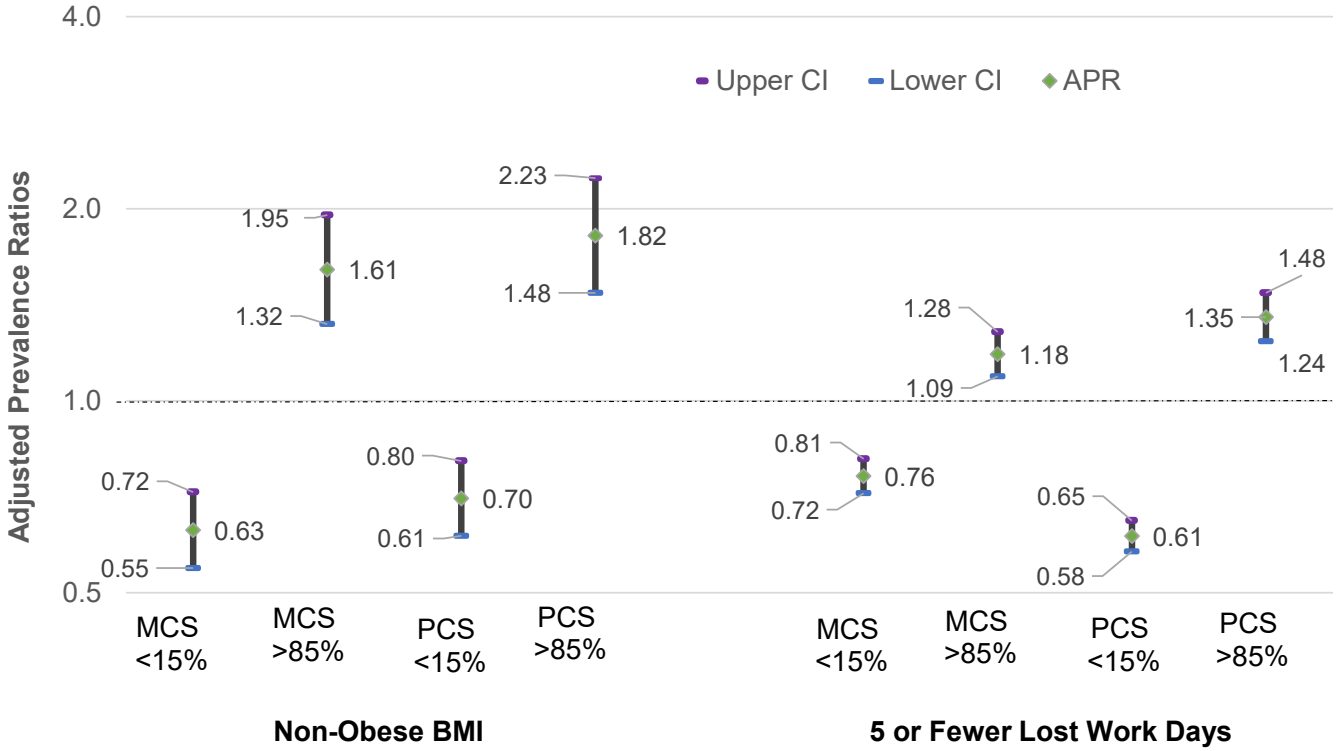
Results show a strong and consistent relationship between MCS and PCS scores in the lowest 15th centile and readiness outcomes. Women scoring in the lowest 15th centile for MCS demonstrated a lower adjusted prevalence of non-obese BMI (APR 0.6, 95% CI 0.6, 0.7) and 5 or fewer lost workdays (APR 0.8, 95% CI 0.7, 0.8). compared to women scoring in the middle 70th centile. These relationships were similar in magnitude and significance for women scoring in the lowest 15th centile for PCS.

TABLE. Active Duty Service Women Baseline Characteristics, Health-related Quality of Life Factors, and Follow-up Readiness Outcomes

Population Total	13,785	
Demographic and Military Characteristics at Baseline	No.	%
Age group, y		
17–24	4,912	35.6
25–34	6,526	47.3
35+	2,347	17.0
Race and ethnicity		
White, non-Hispanic	8,672	62.9
Black, non-Hispanic	2,747	19.9
Hispanic	1,069	7.8
Asian or Pacific Islander	837	6.1
Multi-racial	249	1.8
American Indian or Alaska Native	210	1.5
Missing	1	0
Marital status		
Single	5,269	38.2
Married	6,357	46.1
Other	2,158	15.7
Missing	1	0
Service branch		
Army	4,713	34.2
Navy	2,675	19.4
Marine Corps	406	2.9
Air Force	5,604	40.7
Coast Guard	387	2.8
Rank		
Enlisted	10,225	74.2
Officer	3,560	25.8
Enrollment panel		
Panel 1	5,079	36.8
Panel 2	2,751	20.0
Panel 3	3,235	23.5
Panel 4	2,720	19.7
HRQOL at baseline		
Mental HRQOL		
Lowest 15% (<40.2)	2,046	14.8
Middle 70% (40.2–57.9)	9,553	69.3
Highest 15% (>57.9)	2,047	14.8
Missing	139	1.0
Physical HRQOL		
Lowest 15% (<47.3)	2,056	14.9
Middle 70% (47.3–58.0)	9,592	69.6
Highest 15% (>58.0)	2,052	14.9
Missing	85	0.6
Readiness outcomes at follow-up		
Annual lost work days		
≤5 days	9,119	66.2
>6 days	4,181	30.3
Missing	485	3.5
Obesity status		
Non-obese	11,982	86.9
Obese	1,164	8.4
Missing	639	4.6

Abbreviations: No., number; y, years; HRQOL, health-related quality of life.

FIGURE. Adjusted Prevalence Ratios[a] for Readiness Outcomes by Mental and Physical Health-related Quality of Life Scores Among Active Duty U.S. Service Women



Abbreviations: CI, confidence interval; APR, adjusted prevalence ratio; MCS, mental component summary; PCS, physical component summary; BMI, body mass index.
[a] APRs compare participants scoring in the lowest 15th and highest 85th centiles with those in the middle 70th centile. Multivariable models regressing MCS and PCS scores on readiness outcomes of non-obese BMI and lost work days were adjusted for covariates measured at baseline: age group, race and ethnicity, marital status, pay grade, service branch, enrollment panel. No collinearity was detected among independent variables using a variance inflation factor threshold of 4 or greater (all variance inflation factors < 2.0).

Discussion

Our findings suggest the VR-12 HRQOL instrument may be an efficient screening tool for health factors associated with readiness among service women. Low MCS and PCS scores were consistently associated with decreased likelihood of readiness (i.e., obese BMI and more lost work days). These relationships between HRQOL and readiness persisted after covariate adjustment, suggesting that HRQOL could stand alone as a brief screener for health-related readiness factors. Although these readiness-related outcomes could also be associated with subsequent HRQOL, this study's longitudinal design allowed a temporal assessment of HRQOL with each outcome, supporting a consistent relationship between these more global measures of health (MCS and PCS) and future readiness-related metrics.

The greatest magnitude of association for MCS and PCS was with BMI readiness outcome. As meeting weight standards in the military is tied to retention, this finding is critical to understanding service women's readiness. Research indicates that military service women who become pregnant may need additional support to sustain fitness during and after pregnancy. Recent research found that nearly 40% of active duty service women with a normal pregnancy (i.e., non-eclamptic) did not return to their baseline BMI after pregnancy.[14] The Marine Corps Artemis program, launched in 2021 at Camp Pendleton,[14,15] is designed to support women during and after pregnancy, but the program is limited to 1 service branch.

Additionally, the finding that both MCS and PCS scores are associated with BMI corroborates the proposition that there are mental and emotional components to weight control beyond simple caloric intake versus output.[16] Recent research utilizing Millennium Cohort Study data found that service members who screened positive for mental disorders such as post-traumatic stress disorder (PTSD) or depression were at higher risk for subsequent binge eating disorder.[16] Another study demonstrated that participants who screened positive for PTSD were more likely to experience subsequent weight gain.[17] A study of female veterans reported that military experiences including challenging food environments, sexual trauma, and pregnancy during service negatively affected eating behaviors.[18] Programs designed specifically with a holistic approach to women's weight management could be beneficial in helping them cope with military life stress.[19]

Limitations of this study include the narrow definition of readiness, which may not fully capture all elements of readiness; however, BMI and missed work days are reasonable and objective proxies of duty fitness. MCS and PCS scores may have changed during the follow-up period due to unmeasured factors such as severe illness or injury. Although severe event prevalence is expected to be small, such factors may have biased results towards the null. Nonetheless, MCS and PCS provide global measures of physical and mental health. In fact, recent research on injury status and HRQOL observed MCS and PCS as stable over time, with baseline scores the strongest and most significant predictors of follow-up scores.[20]

This report highlights the need for additional research to better understand female service member readiness, especially with renewed service focus on force lethality and deployability, and potential reviews of fitness and body composition standards.[21] Women-focused research on the unique needs of service women would fulfill a commitment to military women's health and, ultimately, result in a more ready female force.

Author Affiliations
Deployment Health Research Department, Naval Health Research Center, San Diego, CA: Ms. Jacobson, Dr. Castañeda, Ms. Zhu, Dr. Lewis, Dr. Carey; Leidos, Inc., San Diego: Ms. Jacobson, Ms. Zhu, Dr. Lewis

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Case Report

Complicated Breast Cellulitis Status Post-Bilateral Mastectomies Caused by Infection with *Staphylococcus coagulans*

Edwin Kamau, PhD, D(ABMM); Lindsey L. O'Neal, PhD; Kitjawat Tatdanai, BS, MLS(ASCP); Casey W. Harless, PhD; Violet Nxedhlana, PhD, MLS(ASCP); John L. MacArthur, PhD, M(ASCP); Jamie L Dombach, PhD, M(ASCP); Terri Carlson, MD

Staphylococcus schleiferi is an opportunistic pathogen primarily associated with veterinary infections, such as otitis externa and pyoderma, in both dogs and cats.[1] In humans, *S. schleiferi* is a relatively rare cause of nosocomial infections such as bacteremia, endocarditis, wound and surgical site infections, and infections related to medical devices.[2-4] Studies have suggested that humans may acquire this organism through contact with dogs,[1,5,6] but thus far, there is no molecular evidence to confirm this.

Recent comparative genomic analysis taxonomically separated *S. schleiferi* subspecies—*S. schleiferi* subsp. *schleiferi* and *S. schleiferi* subsp. *coagulans*—into 2 species—*S. schleiferi* and *S. coagulans*—with genome phylogeny distinguishing them into 2 monophyletic clusters.[6] *Staphylococcus schleiferi* isolates mostly originate from humans, while *S. coagulans* isolates are found in both animals and humans. Additionally, the subspecies can be distinguished by unique features. The sialidase B gene (*nanB*), has been shown to be a unique marker for *S. schleiferi*, whereas the *chrA* gene is exclusive to *S. coagulans*.[6]

This case study presents a unique instance of *S. coagulans* infection in a 63-year-old female with a history of breast cancer and implant reconstruction for almost 2 decades, who presented with a *S. coagulans* infection of the breast implant. This infection was suspected to have originated from her pet dog, but could not be molecularly proven, nor was there an obvious route of infection. This case highlights the clinical challenges and management strategies involved with the treatment of this *S. coagulans* infection.

Case Presentation

A 63-year-old female with a history of right breast cancer, post-bilateral mastectomies with implant reconstruction 19 years earlier, presented to the emergency department with worsening right breast infection. She had completed a 10-day course of trimethoprim / sulfamethoxazole (bactrim) but continued to report small amount of purulent drainage and redness. She denied experiencing fever, chills, night sweats, nausea, vomiting, abdominal pain, or other complaints. Her vital signs were stable, and laboratory results showed white blood cell (WBC) count, platelets, and neutrophil levels within normal ranges.

A physical examination revealed a small amount of pericapsular fluid near the right breast implant. The patient was referred to plastic surgery, and the right implant was surgically removed by a covering surgeon the following day. Intra-operatively, the patient was noted by report to have extremely thin skin with some compromise, raising concerns about potential skin flap necrosis if capsulectomy were performed, so it was left in place and the incision closed over a drain. A swab specimen was sent to the microbiology laboratory for analysis.

Patient care was transferred from the covering surgeon and was seen on post-operative day 12, when she exhibited purulent drainage and wound dehiscence, prompting the wound to be fully opened for adequate drainage in the clinic, as she refused admission and surgical washout **(Figure 1)**. Fluid was sent to the microbiology laboratory for analysis. Surgical debridement and coverage with a latissimus dorsi flap were recommended, but the patient continued to refuse recommended treatment, so local wound care was continued.

On post-operative day 40, the patient finally agreed to limited surgery and underwent right breast capsulectomy, wound debridement, application of a bilayer wound matrix, and placement of negative pressure wound therapy device. A tissue sample was sent to the microbiology laboratory for further analysis.

The microbiology laboratory identified all isolates from the patient as *S. schleiferi* based on MALDI-TOF (matrix-assisted laser desorption / ionization time-of-flight) analysis, and all isolates were susceptible to all antibiotics tested. The patient was treated with multiple antibiotics, including trimethoprim / sulfamethoxazole, ciprofloxacin, clindamycin, and levofloxacin. She underwent split-thickness skin grafting to achieve wound coverage and at last follow-up 6 weeks later was doing well.

For additional analysis, the isolates from the patient were whole genome sequenced (WGS) on an Illumina MiSeq or NextSeq benchtop sequencer (Illumina, Inc., San Diego, CA), as previously described,[7] and sequence analysis was performed using CLC Genomics Workbench (QIAGEN, Germantown, MD). The patient was also asked to swab her pet dog, and bacterial isolates from the dog identified as *S. schleiferi* by MALDI-TOF were also sequenced.

Based on the initial *k-mer* analysis, the isolates from both the patient and dog closely matched the reference genome CP009762 (https://www.ncbi.nlm.nih.gov/nuccore/CP009762), a canine clinical isolate published in 2015. The patient isolate shared an average nucleotide identity (ANI) of 98.87% with CP009762, while the dog isolates demonstrated an ANI of 99.98%.

Phylogenetic analysis of previously published WGS of *S. schleiferi* from humans and *S. coagulans* from canines, along with the isolates from this study, revealed 2 distinct *S. coagulans* clusters. The isolates from the patient's dog grouped within 1 cluster, whereas the patient's isolate formed a separate *S. coagulans* cluster **(Figure 2)**. All 3 isolates from this study carried the *chrA* gene, a marker exclusive to *S. coagulans*. SNP analysis indicated that the dog isolates were closely related, with only 12 SNP differences, while the patient isolate exhibited 16,038 SNP differences, suggesting no genetic relation.

Discussion

To our knowledge, this is the first report of a breast implant infection caused by *S. coagulans*. When the patient first presented with cellulitis, she was administered multiple antibiotics with no symptom resolution. Interestingly, the bacteria causing the infection were susceptible to the antibiotics with which the patient was treated.

Initially, when asked if she had a pet dog, the patient denied having one. At a later date, after admitting that indeed she had a pet dog, she denied close contact with the animal, nor could she recall experiencing a skin break that may have led to the infection. It is important to note that *S. coagulans* can colonize human skin, especially those in close contact with dogs.[8] Although we could not molecularly confirm that the patient's infection originated from the dog, it is plausible that the patient was first colonized with the bacteria or was directly infected by the dog, but several months may have passed since the bacterial inoculation occurred. Additionally, the patient collected the specimen from the dog's mouth instead of the ears, as initially requested, and the polymicrobial nature of the dog's oral flora may have lowered the chance of obtaining a strain more molecularly related to that found in the patient.

It appeared that this may have been an endogenous infection of the breast implant, which became evident following its surgical removal. For infections related to implants, cure is mostly achieved by device removal, regardless

FIGURE 1. Image of the Wound, Day 12 Post-Operation, Showing Evidence of Purulent Drainage and Gaping Dehiscence

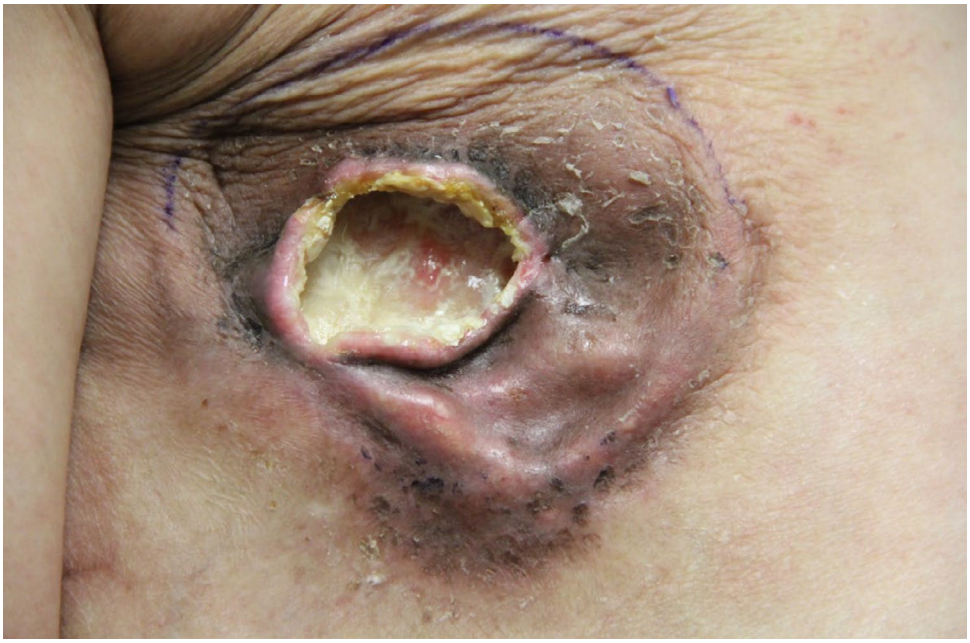
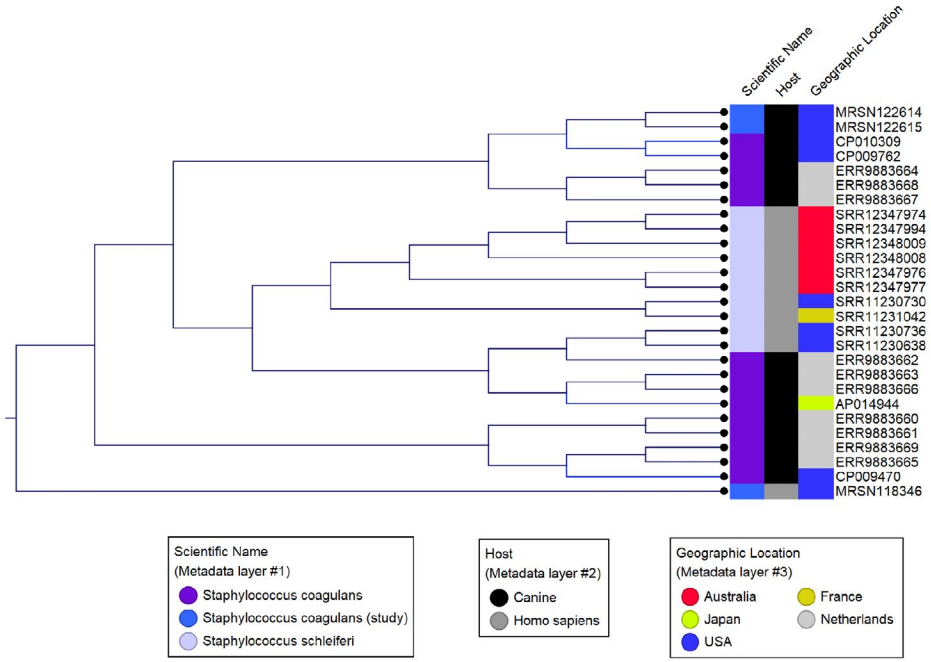


FIGURE 2. *K-mer*-based Phylogenetic Tree Showing *S. schleiferi* and *S. coagulans* Diversity and Relatedness



Note: This tree was constructed using CLC Genomics Workbench (QIAGEN). This approach utilized distance-based methods, employing *k-mer* length and specified distance measures to infer evolutionary relationships among the analyzed genomes. Isolates from our study, canine (MRSN122614, MRSN122615) and Homo sapiens (MRSN118346), were analyzed along with some isolates recently characterized by *Naing et al.*,[6] re-assigning *S. schleiferi* and *S. coagulans* into 2 separate species. Isolates from our studies grouped with *S. coagulans*.

of whether the isolates are susceptible to anti-staphylococcal agents. It has been shown that in surgical infections it can take up to 12 months for a *S. schleiferi* infection to appear.[2] It is plausible that our patient had the infection for some time, forming biofilms that protected the bacteria from her immune system and antibiotics, leading to persistent infections despite susceptibility to the antibiotics of her treatment.[9] This may explain why the patient's vital signs were stable and laboratory markers, including WBC, were within normal range.

A recent study that performed molecular characterization and taxonomic reassignments of the 2 separate species of *S. schleiferi* and *S. coagulans* re-assigned several publicly available reference genomes to the correct species, including CP009762, which is now *S. coagulans*.[6] It is important to clinically differentiate the 2 species due to differences in host preference, pathogenic potentials, antibiotic resistance profiles, and virulence factors.[6,10]

S. schleiferi is an important human pathogen, whereas *S. coagulans* predominantly causes infections in animals, and exhibits greater resistance to antibiotics. Current diagnostic methods routinely used in clinical microbiology laboratories, including MALDI-TOF mass spectrometry, cannot reliably differentiate the 2 species. In our case study, it would have been clinically relevant to immediately provide accurate identification of *S. coagulans* versus *S. schleiferi*. Accurate identification could have significantly influenced initial empirical treatment, given the differences in the drug susceptibility profiles of the organisms. Additionally, precise identification could have provided additional information about the possible source of infection, including pet exposure.

Although MALDI-TOF mass spectrometry can be combined with biochemical property tests for routine identification of *S. coagulans*,[11] development of a molecular test, such as PCR, to facilitate routine differentiation of *S. coagulans* and *S. schleiferi*, is urgently needed. Sasaki *et al.* developed a multiplex PCR method for identifying coagulase-positive *Staphylococcus* species, which could distinguish several species including *S. schleiferi*.[12] It remains unclear, however, whether that test can differentiate *S. coagulans* and *S. schleiferi*, potentially requiring further redevelopment. Such advancements would enhance clinical outcomes by enabling targeted treatment strategies and improving infection control measures.

This case study illustrates the clinical challenges and pathogenicity of *S. coagulans* in patients with medical devices. The successful management of this infection required a multi-disciplinary approach, including surgical intervention, proper identification of the organism, and targeted antibiotic therapy. The development of a method for discriminating between the 2 species is required for routine testing.

Author Affiliations

Tripler Army Medical Center, Honolulu, HI: LTC Kamau, MAJ O'Neal, Mr. Tatdanai, MAJ MacArthur, CPT Dombach, LTC Carlson; Medical Technology Department, University of Hawai'i, Mānoa: Dr. Nxedhlana; Multidrug Resistant Organism Repository and Surveillance Network (MRSN), Walter Reed Army Institute of Research, Silver Spring, MD: Dr. Harless

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Guest Editorial

Preparation for Training in the Heat Season: Key Considerations for Heat Injury Risk Prevention and Mitigation

Gabrielle E. W. Giersch, PhD

Training in the heat substantially increases risk of exertional heat illness, a risk accepted by military units due to the necessity of training in environments similar to those where warfighters may be deployed.[1] Previous work has shown that foot marches (i.e., ruck marches) and timed runs are the activities with highest heat-related illness prevalence.[2] Severe heat-related illnesses, such as exertional heat stroke (EHS), can lead to long recovery times and end organ damage, and constitute a significant threat to force lethality and detriments to deployability.[1,3] While research and guidelines for appropriate conduct of service member activities in hot environments are updated regularly, over 2,500 warfighters continue to be affected by heat-related illnesses annually.[4]

Subject matter experts at the U.S. Army Research Institute of Environmental Medicine (USARIEM) conduct research to both prevent heat-related illness and enhance physical performance in the heat, with a particular emphasis on the needs of the warfighter. USARIEM research has led to key developments for enhancing performance along with prevention and treatment strategies for heat-related illnesses.[5-8] The cumulative knowledge from this work leads to guidelines published (among others) in *Technical Bulletin, Medical: Heat Stress Control and Casualty Management*, which provides resources—including fluid prescription guidelines and work-to-rest ratios—for all flag conditions, as well as details on risk factors to prevent the development of heat illness.[9]

This editorial summarizes the results and conclusions of recent biomedical research on performance and injury risk in the heat, to provide practical considerations for warfighters training in the heat, both for individual warfighters as well as leaders who plan training activities. This editorial describes recent evidence about individualized factors that may influence risk of developing a heat-related illness and strategies to prepare for training in the heat.

Physiology of Exercise Heat Stress and Illness

Thermoregulation during physical activity in the heat has been extensively reviewed in the literature.[9-12] Environmental heat stress, particularly with exercise, increases risk of heat-related illness.[3,13-15] During exercise heat stress, working skeletal muscle produces heat, with the heart rate elevating to increase cardiac output to accommodate the needs of the working skeletal muscle, as well as the skin, for heat dissipation. The primary heat dissipation mechanisms during exercise are evaporation—of sweat from the surface area of the skin—and convection—from air flow over the skin surface in combination with increased skin blood flow.[16-18]

Exertional heat illnesses constitute a spectrum, ranging in severity from heat exhaustion, defined as an inability to continue exercise in the heat, to heat injury, which is defined as heat exhaustion with evidence of end organ damage, and EHS, which is elevated body temperature with altered mental status.[3,19] Altered mental status associated with EHS can also range from change in walking or running gait, to slurred speech, to loss of consciousness.[20] Organ damage is also prevalent in EHS cases, with recent evidence suggesting a possible sex difference in level of end organ damage despite apparent similar EHS severity.[21] Importantly, classic heat stroke differs from EHS: Classic heat stroke more often affects older individuals during heat waves, associated with hot, dry skin and no physical activity, whereas EHS casualties occur more often in younger people sweating due to physical activity.[19]

Preparation Strategies and Considerations

Successful prevention of heat-related illness requires preparation well in advance of heat season; these preparations can include heat acclimatization and increased fitness levels for at least 1 month prior. Heat acclimatization is the most effective means for not only heat stress preparation and decreasing risk of heat-related illnesses, but enhancing performance as well. Heat acclimatization has been extensively investigated, with various protocols demonstrating enhanced performance and thermoregulatory function during heat stress.[22] Heat acclimatization is the process of repeatedly exposing the body to heat stress in a controlled manner, with incremental and gradual increases in exercise intensity to allow beneficial adaptations.[23-25] The primary adaptations of heat acclimatization include decreased resting and exercise body temperatures, lower exercise heart rate, increased sweating rate, and increased physical performance capacity.[23] The process can occur over as little as 4-8 days with longer durations prescribed (e.g., 10-21 days) to ensure greatest possible adaptation.[23-25]

While heat acclimatization is the most effective preparation strategy, increased fitness from training in cool and temperate environments can also enhance performance during training in the heat, and may reduce risk of heat-related illness.[26] Individuals with higher fitness statuses are thought to have preliminary heat adaptations (i.e., partial acclimatization) that are likely due to increases in body temperature during extended exercise, which allow milder adaptations.[10] Endurance training (e.g., running) has been observed to provide the most beneficial adaptations to heat stress.[10] Once training and acclimatization have been achieved, maintenance (i.e., continued exercise or heat

exposure) is important to prevent diminishment of those adaptations.[27]

A key consideration for heat training preparation is awareness of biological and physiological factors that increase risk of heat illness.[28] Recent USARIEM research evaluating risk factors for heat illness among groups and individuals has found that higher body mass index (BMI), which is associated with a lower body surface area to mass ratio (BSA:mass), increases individual risk for EHS.[7,8] Every 1 unit increase in BMI led to a 3% increase in relative EHS risk.[7] Additional work from the Uniformed Services University of the Health Sciences (USUHS) confirmed this effect of BMI.

Research at USUHS also observed increased risk of heat-related illnesses in conjunction with both upper and lower respiratory infections.[29] Lower respiratory infections (e.g., influenza, bronchitis) have strong effects on EHS risk. Adequate recovery from respiratory infections prior to participation in heat training is particularly important for reducing risk of developing an exertional heat-related illness.[29]

Decades of research into prevention of heat-related illnesses and EHS have identified many biological, physiological, behavioral, and environmental risk factors, summarized in the **Table**. This evidence can inform decision-making for unit leaders as well as individuals, for appropriate preparation, adjustment, modification, and completion of training exercises and minimization of heat training casualties.

Mitigation Measures

The ability to cool and diffuse heat before or during training activities is paramount for decreasing risk. The Arm Immersion Cooling System (AICS) is a method used to cool service members prior to, or during, activities of greatest risk.[6] AICS is most effective if the protocol is properly adhered to, specifically resting the arms (wrists to elbows) in cool ice water for 3-5 minutes.[6]

In addition to cooling before and during activity, readily available treatment remedies are vital for ensuring prompt recognition, arrest, and recovery of heat illness casualties. Cooling modalities range in both practicality and effectiveness. Ice water immersion is the 'gold standard' for cooling a heat casualty as quickly as possible[30] but requires a significant amount of ice and water, which can only be used for 1 casualty. Iced sheets is a method with greater practicality but slightly less cooling efficacy. While cooling rates for iced sheets are lower, if used properly—rotated *at least* every 3 minutes—they are an effective means of cooling heat casualties.[5] If iced sheets are not rotated frequently enough, they can trap heat and exacerbate elevated body temperatures.[5]

Injury Identification and Recovery

Prompt identification of a heat casualty can drastically reduce long-term complications, as the amount of time hyperthermic appears to be indicative of the level of damage from the heat illness.[31] Knowing signs and symptoms including altered mental status (AMS), including confusion, change in walking or running gait, slurred speech, and loss of consciousness, are primary examples of AMS.[32,33]

Early identification and initiation of cooling can enhance recovery and return-to-duty (RTD) for heat-related illnesses.[34] RTD and recovery from a heat-related illness vary depending on illness severity.[34] Many heat exhaustion cases can return to duty and training the following day with appropriate guidance and hydration, while EHS cases can require many weeks.[35,36]

EHS cases can range in severity as well, largely dependent on prompt detection, cooling onset, and pre-hospital care.[34,35] Organ damage is common in EHS, with some individuals necessitating organ transplants (usually liver or kidney). Army Regulation 40-501 governs RTD for soldiers and specifies minimum EHS recovery of 10 weeks.[37]

It is commonly suggested that becoming a heat illness casualty, particularly with EHS, puts an individual at an increased risk for subsequent heat illness, but there is limited research to support this assertion. Full and optimal recovery leads to complete RTD, likely without increased risk for future heat illness.[35]

Enhanced Prevention and Mitigation Strategies

The prevalence and impacts of heat-related illnesses, on individual warfighter lethality and medical readiness, make continued research efforts for enhanced performance, prevention, recovery, and RTD for heat-related illnesses of continuing importance. Current mitigation efforts at USARIEM include identification of biomarkers of recovery from heat-related illnesses for enhancing RTD, development of practical heat acclimatization strategies that do not require a laboratory nor hot environment, evaluation of inter-individual variability in heat stress as well as physiological and biomarker responses, and enhanced prevention efforts for both individuals and units.

With most military training installations located in the southeastern U.S., training in the heat is a necessity for the U.S. military. It is critical to ensure appropriate preparation and education of risk factors and signs of heat illness and injury for both individual service members and leadership, for their recognition and mitigation of these risks during training events. While heat-related illnesses, including EHS, are not 100% preventable, mitigation of risk factors and adequate preparation can reduce as many as possible, to optimize the health and lethality of our warfighters—both during training and in battlefield environments.

Author Affiliation
Thermal and Mountain Medicine Division, U.S. Army Research Institute of Environmental Medicine

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TABLE. Commonly Cited Risk Factors for Heat-related Illnesses

Risk Factor	Supporting Evidence
Biological	
Sex	Evidence for sex as a risk factor is mixed and may depend upon illness severity or sociological factors. A case-control analysis that directly evaluated sex and EHS risk found no sex influence, but studies investigating prevalence by heat illness severity show conflicting findings: Earlier findings show women at a greater EHS risk, while more recent findings show men at greater EHS risk and women at greater heat exhaustion risk. If sex difference for heat-related illness risk exists, it may not be related to physiological but, instead, cultural or practical factors (for example, anecdotal reports from allied militaries state that some women may voluntary dehydrate due to limited latrine access, but this remains to be investigated).[7,28,29,38]
Race and ethnicity	Non-Hispanic Black individuals appear to be at greater risk for heat illness, but physiological factors are unclear. Individuals with sickle cell trait (more prevalent in non-Hispanic Black individuals) have increased risk of heat illness, but race has been shown previously to increase risk independent of sickle cell trait status.[39]
BMI	Each 1 unit increase in BMI is associated with 3% increase in relative EHS risk, along with higher risk of more minor heat illness.[7]
Physiological	
Acclimatization	Gradual adaptation to heat decreases heat illness risk.[3,23]
Poor physical fitness	Poorer fitness status increases risk for heat-related illness.[10,26]
Respiratory infection	Respiratory infections affect risk for all forms of heat illness.[29]
Behavioral	
Hydration	Hydration before and during activity can reduce risk of heat-related illness. Dehydration increases body temperature during training in heat and increases rate of body temperature rise. Dehydration may influence performance and ability to continue activity. While starting an activity well-hydrated and remaining hydrated help reduce heat illnesses risk, hydration alone does not protect individuals from heat illness. Hydration is only 1 of many risk mitigation measures. Avoiding alcohol 48-72 hours prior to training can help maintain appropriate hydration, as alcohol acts as a diuretic.[40] Alcohol can also induce fatigue or alcohol-related symptomology during training.[41-43]
Supplementation and medication	Certain medications and supplements (e.g., stimulants) can increase body temperature, with potential increased heat illness risk, but no direct risk analysis has been conducted. Energy drinks with high amounts of caffeine and supplements are not regulated by the FDA and may contain harmful ingredients that can exacerbate elevated body temperature during exercise and heat stress, and may may influence heat-related illness risk.[44-46]
Sleep	Although often characterized as a risk factor, there is limited evidence to support the assertion that sleep deprivation is a risk factor for heat illness; no physiological mechanism is known. Adequate sleep may help ensure best preparation for training and thereby aid risk reduction for heat-related illness.[47]
Personal motivation	Individuals inclined to exert themselves harder (e.g., candidates for promotion or elite level training) are at increased risk if inclined to ignore or minimize accepted physiological or perceptual indicators of fatigue or overheating.[48]
Environmental	
Weather	Radiant heat load and humidity are factors in high WBGT, an aggregate temperature measure incorporated in DOD guidelines, which allow for flexible training times (e.g., earlier in the day), reduced radiant heat loads, work-to-rest ratios, and fluid replacement guidelines. Other weather factors such as heat index or UTCI have been proposed, but the most widely accessible, with greatest data, is WBGT.[49-51]
Load carriage	Higher weight loads intensify body heat production and thereby increase physical burden to diffuse that heat.[9]
Clothing	Greater clothing insulation (e.g., Army combat uniforms) increase thermal load of an activity by decreasing capacity for heat dissipation.[9]

Abbreviations: EHS, exertional heat stroke; BMI, body mass index; FDA, Food and Drug Administration; WBGT, wet-bulb globe temperature; DOD, Department of Defense; UTCI, Universal Thermal Climate Index.

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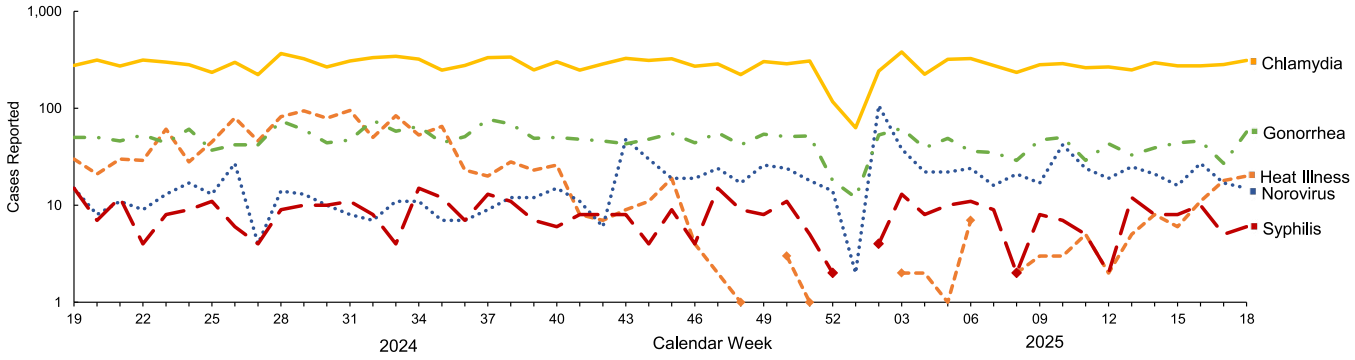
Reportable Medical Events at Military Health System Facilities Through Week 18, Ending May 3, 2025

Idalia Aguirre, MPH; Matthew W.R. Allman, MPH; Anthony R. Marquez, MPH; Katherine S. Kotas, MPH

TOP 5 REPORTABLE MEDICAL EVENTS[a] BY CALENDAR WEEK, ACTIVE COMPONENT (MAY 11, 2024 - MAY 3, 2025)



Abbreviation: RMEs, reportable medical events.

[a]Cases are shown on a logarithmic scale.

Note: There were 0 reported heat illness cases during weeks 49, 52, 2, and 7. There were no syphilis cases reported during week 1 of 2025.

Reportable Medical Events (RMEs) are documented in the Disease Reporting System internet (DRSi) by health care providers and public health officials throughout the Military Health System (MHS) for monitoring, controlling, and preventing the occurrence and spread of diseases of public health interest or readiness importance. These reports are reviewed by each service's public health surveillance hub. The DRSi collects reports on over 70 different RMEs, including infectious and non-infectious conditions, outbreak reports, STI risk surveys, and tuberculosis contact investigation reports. A complete list of RMEs is available in the *2022 Armed Forces Reportable Medical Events Guidelines and Case Definitions*.[1] Data reported in these tables are considered provisional and do not represent conclusive evidence until case reports are fully validated.

Total active component cases reported per week are displayed for the top 5 RMEs for the previous year. Each month, the graph is updated with the top 5 RMEs, and is presented with the current month's (April 2025) top 5 RMEs, which may differ from previous months. COVID-19 is excluded from these graphs due to changes in reporting and case definition updates in 2023.

For questions about this report, please contact the Disease Epidemiology Branch at the Defense Centers for Public Health–Aberdeen. Email: dha.apg.pub-health-a.mbx.disease-epidemiologyprogram13@health.mil

Authors' Affiliation: Defense Health Agency, Disease Epidemiology Branch, Defense Centers for Public Health–Aberdeen

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TABLE. Reportable Medical Events, Military Health System Facilities, April 2025[a]

Reportable Medical Event[b]	Active Component[c]					MHS Beneficiaries[d]
	April 2025	March 2025	YTD 2025	YTD 2024	Total 2024	April 2025
	No.	No.	No.	No.	No.	No.
Amebiasis	0	1	7	5	15	0
Arboviral diseases, neuroinvasive and non-neuroinvasive	0	0	0	0	3	0
Botulism	0	0	0	0	0	1
Brucellosis	0	0	0	0	1	0
COVID-19-associated hospitalization and death	1	8	16	18	41	14
Campylobacteriosis	29	27	90	70	326	12
Chikungunya virus disease	0	0	0	0	1	0
Chlamydia trachomatis	1,281	1,116	4,739	5,575	15,664	167
Cholera	0	0	0	1	3	0
Coccidioidomycosis	3	2	7	29	53	2
Cold weather injury[e]	25	21	255	129	174	N/A
Cryptosporidiosis	6	5	22	26	82	3
Cyclosporiasis	1	1	2	0	11	0
Dengue virus infection	1	2	4	4	12	0
E. coli, Shiga toxin-producing	5	3	14	18	93	4
Ehrlichiosis/anaplasmosis	0	0	0	0	1	0
Giardiasis	9	7	31	35	98	3
Gonorrhea	178	165	702	982	2,770	17
Haemophilus influenzae, invasive	1	0	2	2	3	0
Hantavirus disease	0	0	0	0	0	1
Heat illness[e]	53	17	88	95	1,275	N/A
Hepatitis A	0	0	0	3	7	0
Hepatitis B, acute and chronic	7	5	24	41	105	4
Hepatitis C, acute and chronic	3	2	10	12	28	3
Influenza-associated hospitalization[f]	7	4	44	32	54	11
Lead poisoning, pediatric[g]	N/A	N/A	N/A	N/A	N/A	6
Legionellosis	0	0	0	3	5	1
Leprosy	0	0	0	0	1	0
Listeriosis	0	0	1	0	0	0
Lyme disease	3	6	12	23	101	6
Malaria	1	1	2	3	21	1
Measles	0	0	0	0	0	1
Meningococcal disease	0	0	0	0	2	0
Mpox	0	1	2	4	14	0
Mumps	0	0	1	0	0	2
Norovirus	81	122	469	126	654	82
Pertussis	4	6	19	6	39	6
Post-exposure prophylaxis against Rabies	47	44	167	191	635	36
Q fever	0	0	0	0	3	0
Salmonellosis	12	8	30	31	160	18
Schistosomiasis	0	0	0	0	1	0
Shigellosis	3	3	10	16	53	0
Spotted Fever rickettsiosis	3	1	7	4	22	1
Syphilis (all)[h]	31	28	124	220	518	12
Toxic shock syndrome	0	0	0	2	2	0
Trypanosomiasis	0	0	1	1	5	0
Tuberculosis	1	1	2	1	6	0
Tularemia	0	0	0	1	1	0
Typhoid fever	0	0	0	0	1	0
Typhus fever	0	0	1	1	2	0
Varicella	1	0	3	4	18	3
Zika virus infection	0	0	0	1	1	0
Total case counts	1,797	1,607	6,908	7,715	23,085	417

Abbreviations: MHS, Military Health System; YTD, year-to-date; no., number; *E., Escherichia*; N/A, not applicable.

[a] RMEs submitted to DRSi as of Jun. 23, 2025. RMEs were classified by date of diagnosis or, where unavailable, date of onset. Monthly comparisons are displayed for the periods Mar. 1, 2025–Mar. 31, 2025 and Apr. 1, 2025–Apr. 30, 2025. YTD comparison is displayed for the period of Jan. 1, 2025–Apr. 30, 2025 for MHS facilities. Previous year counts are provided as the following: previous YTD, Jan. 1, 2024-Apr. 30, 2024; total 2024, Jan. 1, 2024–Dec. 31, 2024.

[b] RME categories with 0 reported cases among active component service members and MHS beneficiaries for the periods covered were not included in this report.

[c] Services included in this report include the Army, Navy, Air Force, Marine Corps, Coast Guard, and Space Force, including personnel classified as Active Duty, Cadet, Midshipman, or Recruit in DRSi.

[d] Beneficiaries include individuals classified as Retired and Family Members (including Spouse, Child, Other, Unknown). National Guard, Reservists, civilians, contractors, and foreign nationals were excluded from these counts.

[e] Only reportable for service members.

[f] Influenza-associated hospitalization is reportable only for individuals younger than age 65 years.

[g] Pediatric lead poisoning is reportable only for children aged 6 years or younger.

[h] The observed drop in syphilis cases from 2024 to 2025 may be due, in part, to an updated case validation process that began Jan. 2024.

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