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# External Cause Coding of Injury Encounters in the Military Health System Among Active Component U.S. Service Members, 2016–2019

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Knowledge of injury causes is essential for prevention. To investigate cause coding in service members' electronic medical records, injury encounters from 2016 to 2019 containing at least 1 external cause code were analyzed. Approximately 10% of incident injury encounters contained at least 1 cause code describing the mechanism, activity, or place of occurrence. Less than 2% of overuse injury encounters had a cause code each year, compared to 36.4–44.0% of acute injuries occurring from 2016 to 2019. Cause coding occurred more frequently in records from military facilities compared to outsourced care ($p < 0.001$). Inpatient records were more likely to be cause-coded than outpatient records ($p < 0.001$). More injury encounters in emergency clinics were cause coded (> 50%), compared to approximately 7% of primary care and 2% of specialist encounters. In 2019, the leading mechanism was overexertion (19.9%), followed by falls, slips, or trips (18.7%). The primary activity associated with injuries was running (21.1%). Military training ground was the leading place of occurrence (13.0%). Improvements to the quality and quantity of external cause coding in the medical records would provide critical details to inform military injury prevention.

**What are the new findings?**

From 2016 through 2019, approximately 10% of 1.5 million annual U.S. service member incident injury medical encounters contained external cause codes. Acute injuries were approximately 20 times more likely to receive a cause code than overuse injuries. Causes were less likely to be recorded in outpatient care records and at non-military health care facilities.

**What is the impact on readiness and force health protection?**

Injuries are the leading reason for service members to seek health care and contribute significantly to military medical non-readiness. Specific and accurate recording of injury cause codes by health care providers establishes and develops a data-informed mechanism for the design, implementation, prioritization, and monitoring of interventions and prevention programs to reduce injury risk among service members.

Injuries have been the leading reason for medical encounters and limited duty among U.S. active duty service members.[1] In 2018, 2 of every 5 medical encounters among service members were due to injury, resulting in over 4.7 million encounters affecting over 675,000 service members.[2] Military injury surveillance efforts have estimated that injuries annually result in approximately 25 million days of limited duty within the U.S. Army, Navy, Marine Corps, and Air Force.[3]

U.S. service members receive care for injuries and other health conditions through the Military Health System (MHS), which has a dual health care and readiness mission with a focus on promoting and sustaining health.[4,5] As part of a health care encounter, diagnosis and cause codes are entered into electronic medical records by health care providers and, when possible, by medical coders for selected care such as hospitalizations or emergency clinic visits. External cause of injury codes can capture the intent (unintentional or intentional), how the injury occurred (mechanism), the activity at the time of the injury event (activity), and the location where the event occurred (place of occurrence). For injuries, summaries of cause codes from electronic medical records facilitate a data-driven approach and optimize resources by directing efforts to develop relevant injury prevention and treatment plans.[6,7]

There is no national requirement to assign external cause of injury codes in medical records,[8] although the value of injury cause coding to identify intervention opportunities and monitor effects of prevention programs and policies has been noted in International Classification of Diseases, 10th Revision, Clinical Modification (ICD-10-CM) coding guidance and previous epidemiological investigations.[8-11] Military leaders recognize that cause information is needed to reduce injuries.[12-14] To date, however, injury cause coding of military medical records remains incomplete.[9,10,15,16]

Previous publications have summarized external causes of injury for subsets of U.S. military data.[10,16-18] The purpose of this article is to describe causes of injury for all U.S. service members, from 2016 through 2019, and identify variations in injury cause coding over time and by branch of military service, type of health care visit and facility, and diagnosis category.

## Methods

Data consisted of injury medical records maintained in the Defense Medical Surveillance System that were obtained by the authors from the Armed Forces Health Surveillance Division in 2022. Specifically, records were obtained from the Comprehensive Ambulatory/Professional Encounter Record (CAPER), Standard Inpatient Data Record (SIDR), and TRICARE Encounter Data Non-Institutional (TED-NI) and Institutional (TED-I) files. Prior surveillance analyses indicated that more than 99.5% of incident injury records contained 9 diagnoses or less, therefore 9 diagnosis (DX) positions were requested. The records documented ambulatory (outpatient) encounters and hospitalizations (inpatient) that occurred in fixed military medical facilities worldwide and civilian treatment facilities (outsourced care) if reimbursement was sought through the MHS.

The Taxonomy of Injuries[19] was used to identify injuries, from 2016 through 2019, among active component service members in the Army, Navy, Marine Corps, or Air Force. Diagnoses are primarily from ICD-10-CM Chapter 13 ('M' codes primarily for micro-traumatic overuse injuries; diseases of the musculoskeletal system and connective tissue) and Chapter 19 ('S' and 'T' codes for acute injuries; injury, poisoning, and certain other consequences of external causes). Incident injury diagnoses in the primary diagnosis (DX1) position matching Taxonomy diagnosis codes were included, in accordance with standardized military injury surveillance methodology, excluding codes for subsequent and sequela encounters (i.e., ICD-10-CM codes with D or S suffixes). Incident injuries were the focus of the analysis, given that MHS coding guidance specifies assignment of external cause codes to initial encounters. To identify incident injuries, a 60-day gap-in-care rule was applied by injury type and injured body part, to exclude follow-up visits for the same service members within 60 days.[19]

Next, injury medical records containing at least 1 external cause code in diagnosis (DX) positions (1 - 9) were identified. National Center for Health Statistics (NCHS) categorizations of external cause codes (ICD-10-CM Chapter 20, 'V' - 'Y' codes) were adapted for use.[20] In alignment with NCHS, a subset of injury diagnosis codes from ICD-10-CM Chapter 19 that describe the injury mechanism were also included as cause codes (T14.91, T15 - T19, T36 - T65, T71, T73 - T76, U07, V00 - V99, W00 - X58, X71 - X83, X92 - Y09, Y21 - Y33, Y35 - Y38). Cause codes of all intentions (unintentional, intentional, assault, legal intervention / war, undetermined) were included. Codes for unspecified mechanisms were identified in accordance with the NCHS-defined 'Unspecified' category.[20] Given that these codes do not provide actionable information for injury prevention, records that included only these unspecified codes were excluded, but counts are noted in table footnotes. If an unspecified cause code was used in conjunction with a more detailed cause code, the more detailed cause was reported.

Activity codes are ICD-10-CM external cause codes with 'Y93' as the first 3 digits in any diagnosis position.[8,21] Similarly, place of occurrence codes are any cause codes with 'Y92' as the first 3 digits in any diagnosis position.[8,21] Activity and place of occurrence subsets each have only 1 Unspecified code, Y93.9 ("Activity, unspecified") and Y92.9 ("Unspecified place or not applicable"), which were excluded from this analysis in a similar fashion as the unspecified mechanism codes.

The percentage of incident injury records with at least 1 external cause code are reported by ICD-10-CM chapter, care source (direct or outsourced), visit type (inpatient or outpatient), military treatment facility type (medical center, hospital, or clinic),[22] and clinic type (emergency, primary care, specialist). Military treatment facility type for each record was identified by the Defense Medical Information System identifier assigned to the record. For outpatient military treatment facility encounters, Medical Expense and Performance Reporting System codes[23] were also provided and used for categorization into 3 broad clinical groups: emergency, primary care, and specialist.

Data prior to 2020 are presented in this report, due to the fact that more recent data were affected by pandemic-related changes in service member health care provision and the transition to a new electronic health record, MHS GENESIS.[24] Data were not available for 4 sites—Naval Health Clinic Oak Harbor, Naval Hospital Bremerton, Air Force Medical Services Fairchild, Madigan Army Medical Center—that were the first to transition to GENESIS from 2017 through 2019; these sites were not included in this analysis, due to data completeness concerns related to this initial transition period.

Statistical analyses were conducted in SAS™ version 9.4. Proportions of incident injuries receiving mechanism, activity, or place codes are reported. Chi-square tests were used to evaluate differences in proportions across categories and identify statistically significant temporal trends. This project was reviewed and approved as public health practice by the Defense Centers for Public Health–Aberdeen (DCPH-A) Public Health Review Board.

## Results

From 2016 through 2019, there were 5,973,994 incident medical encounter records for injuries across all services. Only 10.0% of incident injury encounter records (n=594,404) received a cause code **(Table 1)**. **Tables 1** and **2** show the numbers and percentages of cause-coded incident injuries.

On average, there were 118,000 total mechanism cause codes assigned to injury records each year (range: 101,281 - 131,105), including instances in which multiple codes were assigned to the same injury **(Table 1)**. During this period, on average, 7.9% of incident injury records were given a mechanism code, 3.8% received an activity code, and 2.5% received a place of occurrence code annually.

From 2016 through 2019, 9–16% of mechanism cause codes were categorized as Unspecified (e.g., X58.X, "exposure to other specified factors"; Y37.90, "military operations, unspecified"). Likewise, 3–6% of activity codes and 17–22% of place of occurrence codes were Unspecified codes. Unspecified codes are reported in the footnotes of **Tables 1** and **2**.

**TABLE 1.** Percentage of Incident Injuries[a,b] with at Least 1 Specified Cause Code Mechanism, Activity, or Place of Occurrence by Service, Active Component, U.S. Armed Forces, 2016–2019

| Cause-Coded Injury Encounters | Total, All Services | | Army | | Navy | | Air Force | | Marine Corps | |
|---|---|---|---|---|---|---|---|---|---|---|
| | No. | % | No. | % | No. | % | No. | % | No. | % |
| Any external cause code[c] | | | | | | | | | | |
| 2016 | 138,448 | 9.2 | 70,183 | 10.0 | 22,816 | 9.6 | 30,233 | 8.0 | 15,216 | 8.4 |
| 2017 | 147,754 | 10.0 | 75,265 | 11.0 | 23,826 | 10.2 | 32,278 | 8.5 | 16,385 | 9.0 |
| 2018 | 148,990 | 10.4 | 75,009 | 11.7 | 24,362 | 10.4 | 32,927 | 8.7 | 16,692 | 8.9 |
| 2019 | 159,212 | 10.3 | 81,310 | 11.7 | 25,438 | 10.0 | 34,629 | 8.8 | 17,835 | 8.8 |
| 2016-2019 | 594,404 | 10.0 | 301,767 | 11.1 | 96,442 | 10.0 | 130,067 | 8.5 | 66,128 | 8.8 |
| Mechanism | | | | | | | | | | |
| 2016 | 101,281 | 6.8 | 50,399 | 7.2 | 17,566 | 7.4 | 21,932 | 5.8 | 11,384 | 6.3 |
| 2017 | 117,832 | 8.0 | 60,450 | 8.8 | 20,102 | 8.6 | 24,638 | 6.5 | 12,642 | 6.9 |
| 2018 | 122,411 | 8.5 | 62,490 | 9.8 | 20,769 | 8.9 | 25,898 | 6.8 | 13,254 | 7.1 |
| 2019 | 131,105 | 8.5 | 67,934 | 9.8 | 22,026 | 8.6 | 27,294 | 6.9 | 13,851 | 6.8 |
| 2016-2019 | 472,629 | 7.9 | 241,273 | 8.9 | 80,463 | 8.4 | 99,762 | 6.5 | 51,131 | 6.8 |
| Activity | | | | | | | | | | |
| 2016 | 53,208 | 3.5 | 28,654 | 4.1 | 7,689 | 3.2 | 10,504 | 2.8 | 6,361 | 3.5 |
| 2017 | 57,560 | 3.9 | 30,031 | 4.4 | 8,354 | 3.6 | 11,700 | 3.1 | 7,475 | 4.1 |
| 2018 | 55,844 | 3.9 | 28,709 | 4.5 | 8,543 | 3.6 | 11,574 | 3.1 | 7,018 | 3.8 |
| 2019 | 59,012 | 3.8 | 31,051 | 4.5 | 8,193 | 3.2 | 12,186 | 3.1 | 7,582 | 3.7 |
| 2016-2019 | 225,624 | 3.8 | 118,445 | 4.4 | 32,779 | 3.4 | 45,964 | 3.0 | 28,436 | 3.8 |
| Place of occurrence | | | | | | | | | | |
| 2016 | 35,503 | 2.4 | 12,783 | 1.8 | 6,852 | 2.9 | 10,992 | 2.9 | 4,872 | 2.7 |
| 2017 | 38,078 | 2.6 | 15,508 | 2.3 | 6,698 | 2.9 | 10,708 | 2.8 | 5,164 | 2.8 |
| 2018 | 37,656 | 2.6 | 14,509 | 2.3 | 7,883 | 3.4 | 9,998 | 2.6 | 5,266 | 2.8 |
| 2019 | 38,089 | 2.5 | 14,825 | 2.1 | 7,664 | 3.0 | 9,969 | 2.5 | 5,631 | 2.8 |
| 2016-2019 | 149,326 | 2.5 | 57,625 | 2.1 | 29,097 | 3.0 | 41,667 | 2.7 | 20,933 | 2.8 |

Abbreviation: No., number.
[a] Excludes encounters that received only cause codes for unspecified mechanisms (T14.91, X58.X, Y09.X, Y35.9, Y36.89, Y36.90, Y37.90, Y38.80), unspecified activity (Y93.3), and/or unspecified place (Y92.9); 2016 n=2,499, 2017 n=1,305, 2018 n=1,251, 2019 n=1,138.
[b] Incident injuries defined by the Taxonomy of Injuries, with a 60-day gap-in-care incidence rule applied to injury type and injured body region. Total incident injury encounters: 2016: 1,500,090; 2017: 1,481,180; 2018: 1,438,012; 2019: 1,554,712.
[c] Note: "Any" category may not equal sum of subcategories, since encounters may have multiple mechanism, activity, and/or place codes.

Among all services, there were more incident injury records with at least 1 cause code in later years, increasing from 9.2% in 2016 to 10.3% in 2019 (**Table 1**, $p<0.0001$ for all comparisons). Compared to other services, the Army had a higher proportion (range: 10.0-11.7%) of records with at least 1 cause code ($p<0.001$).

Incident injury records with 'S' and 'T' diagnosis codes (predominantly acute injuries) contained at least 1 cause code over one-third of the time **(Table 2)** and around 20 times more often than injuries receiving an 'M' code (overuse injuries, <2% cause-coded) or other diagnoses (about 1%) ($p<0.001$). A comparison by care source **(Table 2)** shows a significantly higher proportion of cause-coded incident injury records at military hospitals and clinics (range: 9.5-10.8%) compared to outsourced care facilities (range: 7.7-8.2%). In addition, inpatient injury records (range: 32.0-40.5%) were more likely to have a cause code compared to outpatient care (range: 9.2-10.3%). Considering treatment facility size, for all services incident injuries treated at military hospitals had the highest proportions of cause-coded records (range: 17.5-19.6%), followed by military medical centers (range: 17.0-19.5%) and clinics (range: 6.1-7.1%). From 2016 through 2019, more than half (range: 53.1-57.1%) of emergency care injury records at military facilities were cause-coded, compared to around 7% from primary care (range: 6.3-7.4%) and less than 3% from specialty care (range: 2.3-2.9%).

After the ICD-10-CM 'Overexertion' mechanism cause code was introduced in 2017,[17] the proportion of injury records cause-coded as Overexertion increased

**TABLE 2.** Percentage of Incident Injuries with at Least 1 Specified External Cause Code[a,b] by ICD-10-CM Chapter, Care Source, Clinic Type, Military Hospital or Clinic Size, and Service, Active Component, U.S. Armed Forces, 2016–2019

| | | Total, All Services | | Army | | Navy | | Air Force | | Marine Corps | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | No. | % | No. | % | No. | % | No. | % | No. | % |
| ICD-10-CM chapter | S00 - T99 | | | | | | | | | | |
| | 2016 | 121,916 | 36.4 | 60,762 | 42.1 | 21,000 | 33.1 | 26,349 | 33.7 | 13,805 | 28.3 |
| | 2017 | 130,565 | 41.4 | 66,195 | 48.0 | 21,858 | 37.5 | 27,823 | 38.1 | 14,689 | 32.0 |
| | 2018 | 131,262 | 42.6 | 65,931 | 49.2 | 22,119 | 38.8 | 28,273 | 39.1 | 14,939 | 33.1 |
| | 2019 | 138,852 | 44.0 | 70,411 | 50.7 | 23,160 | 39.3 | 29,544 | 40.6 | 15,737 | 34.7 |
| | M00 - M99 | | | | | | | | | | |
| | 2016 | 15,609 | 1.5 | 8,977 | 1.7 | 1,659 | 1.1 | 3,645 | 1.3 | 1,328 | 1.1 |
| | 2017 | 16,074 | 1.5 | 8,555 | 1.7 | 1,797 | 1.1 | 4,147 | 1.4 | 1,575 | 1.3 |
| | 2018 | 16,525 | 1.6 | 8,462 | 1.8 | 1,983 | 1.2 | 4,443 | 1.6 | 1,637 | 1.2 |
| | 2019 | 18,933 | 1.7 | 10,183 | 2.0 | 1,964 | 1.1 | 4,823 | 1.6 | 1,963 | 1.3 |
| | Other | | | | | | | | | | |
| | 2016 | 923 | 1.0 | 444 | 1.1 | 157 | 1.0 | 239 | 1.2 | 83 | 0.7 |
| | 2017 | 1,115 | 1.3 | 515 | 1.3 | 171 | 1.1 | 308 | 1.5 | 121 | 1.0 |
| | 2018 | 1,203 | 1.5 | 616 | 1.7 | 260 | 1.7 | 211 | 1.1 | 116 | 1.1 |
| | 2019 | 1,427 | 1.6 | 716 | 1.8 | 314 | 1.7 | 262 | 1.3 | 135 | 1.2 |
| Care source | Military hospital or clinic (direct care) | | | | | | | | | | |
| | 2016 | 121,731 | 9.5 | 65,019 | 10.4 | 18,639 | 9.4 | 24,996 | 8.2 | 13,077 | 8.3 |
| | 2017 | 130,648 | 10.3 | 69,810 | 11.5 | 19,924 | 10.3 | 26,595 | 8.6 | 14,319 | 9.0 |
| | 2018 | 130,461 | 10.8 | 69,214 | 12.3 | 19,996 | 10.5 | 26,691 | 8.9 | 14,560 | 9.0 |
| | 2019 | 139,528 | 10.7 | 75,020 | 12.3 | 20,789 | 10.1 | 28,085 | 9.1 | 15,634 | 8.9 |
| | Non-military (outsourced care) | | | | | | | | | | |
| | 2016 | 16,717 | 7.7 | 5,164 | 6.4 | 4,177 | 10.5 | 5,237 | 7.3 | 2,139 | 8.6 |
| | 2017 | 17,106 | 8.0 | 5,455 | 7.1 | 3,902 | 9.7 | 5,683 | 7.8 | 2,066 | 8.7 |
| | 2018 | 18,529 | 8.2 | 5,795 | 7.4 | 4,366 | 9.9 | 6,236 | 7.9 | 2,132 | 8.8 |
| | 2019 | 19,684 | 8.0 | 6,290 | 7.4 | 4,649 | 9.5 | 6,544 | 7.7 | 2,201 | 8.5 |
| Visit type | Inpatient | | | | | | | | | | |
| | 2016 | 976 | 32.0 | 522 | 35.5 | 164 | 29.3 | 128 | 22.7 | 162 | 35.8 |
| | 2017 | 1,061 | 34.4 | 569 | 38.1 | 166 | 29.4 | 146 | 29.4 | 180 | 38.9 |
| | 2018 | 1,207 | 39.1 | 600 | 42.3 | 205 | 36.2 | 175 | 29.2 | 227 | 44.9 |
| | 2019 | 1,188 | 40.5 | 614 | 44.2 | 219 | 40.2 | 160 | 28.5 | 195 | 44.2 |
| | Outpatient | | | | | | | | | | |
| | 2016 | 137,472 | 9.2 | 69,661 | 9.9 | 22,652 | 9.6 | 30,105 | 8.0 | 15,054 | 8.3 |
| | 2017 | 146,693 | 9.9 | 74,696 | 10.9 | 23,660 | 10.1 | 32,132 | 8.5 | 16,205 | 8.9 |
| | 2018 | 147,783 | 10.3 | 74,409 | 11.7 | 24,157 | 10.3 | 32,752 | 8.7 | 16,465 | 8.8 |
| | 2019 | 158,024 | 10.2 | 80,696 | 11.7 | 25,219 | 9.9 | 34,469 | 8.8 | 17,640 | 8.7 |
| Size of military hospital or clinic | Hospital | | | | | | | | | | |
| | 2016 | 37,097 | 17.5 | 17,876 | 18.8 | 5,541 | 18.0 | 8,820 | 14.8 | 4,860 | 17.9 |
| | 2017 | 38,422 | 18.6 | 18,687 | 20.6 | 5,143 | 18.0 | 8,932 | 15.0 | 5,660 | 20.3 |
| | 2018 | 39,528 | 19.6 | 18,882 | 21.8 | 4,622 | 18.0 | 9,715 | 15.9 | 6,309 | 22.6 |
| | 2019 | 41,564 | 19.5 | 20,137 | 21.7 | 5,117 | 16.2 | 10,141 | 15.6 | 6,169 | 20.0 |
| | Medical center | | | | | | | | | | |
| | 2016 | 33,730 | 17.0 | 17,197 | 16.9 | 8,388 | 17.5 | 4,120 | 14.9 | 4,025 | 19.2 |
| | 2017 | 35,016 | 17.8 | 17,011 | 17.0 | 9,559 | 19.5 | 4,303 | 15.7 | 4,143 | 20.0 |
| | 2018 | 35,717 | 19.1 | 17,290 | 19.1 | 10,064 | 21.4 | 4,096 | 14.9 | 4,267 | 21.4 |
| | 2019 | 37,495 | 19.5 | 18,482 | 19.5 | 10,207 | 21.4 | 4,175 | 14.9 | 4,631 | 21.3 |
| | Clinic | | | | | | | | | | |
| | 2016 | 50,273 | 6.1 | 29,683 | 7.4 | 4,627 | 4.0 | 12,041 | 5.5 | 3,922 | 4.1 |
| | 2017 | 56,528 | 6.9 | 33,810 | 8.7 | 5,114 | 4.5 | 13,341 | 6.1 | 4,233 | 4.3 |
| | 2018 | 54,640 | 7.0 | 32,701 | 9.2 | 5,369 | 4.6 | 12,851 | 6.1 | 3,819 | 2.9 |
| | 2019 | 59,639 | 7.1 | 35,908 | 9.3 | 5,404 | 4.3 | 13,653 | 6.4 | 4,674 | 4.1 |
| Type of military outpatient clinic | Emergency | | | | | | | | | | |
| | 2016 | 61,348 | 53.1 | 28,582 | 55.0 | 12,742 | 55.2 | 11,948 | 50.8 | 8,076 | 47.7 |
| | 2017 | 61,839 | 57.1 | 26,732 | 58.0 | 13,444 | 60.4 | 13,347 | 56.5 | 8,316 | 50.6 |
| | 2018 | 64,213 | 57.0 | 27,745 | 59.6 | 13,852 | 60.3 | 13,773 | 55.9 | 8,843 | 48.0 |
| | 2019 | 68,224 | 56.4 | 29,775 | 60.1 | 14,587 | 58.6 | 14,371 | 57.3 | 9,491 | 44.3 |
| | Primary care | | | | | | | | | | |
| | 2016 | 45,398 | 6.3 | 29,061 | 8.1 | 3,539 | 3.8 | 9,640 | 4.8 | 3,158 | 4.5 |
| | 2017 | 52,687 | 7.4 | 34,969 | 10.2 | 3,781 | 4.1 | 10,100 | 5.0 | 3,837 | 5.0 |
| | 2018 | 50,209 | 7.4 | 33,256 | 10.5 | 3,252 | 3.7 | 9,812 | 5.1 | 3,389 | 5.0 |
| | 2019 | 53,824 | 7.4 | 36,614 | 10.6 | 3,136 | 3.1 | 10,494 | 5.3 | 3,580 | 4.2 |
| | Specialist | | | | | | | | | | |
| | 2016 | 8,747 | 2.3 | 3,313 | 1.8 | 1,983 | 2.8 | 2,082 | 2.6 | 1,379 | 2.6 |
| | 2017 | 10,275 | 2.6 | 4,375 | 2.3 | 2,271 | 3.2 | 1,973 | 2.5 | 1,656 | 3.2 |
| | 2018 | 10,514 | 2.8 | 4,717 | 2.7 | 2,453 | 3.6 | 1,942 | 2.5 | 1,402 | 2.6 |
| | 2019 | 11,831 | 2.9 | 4,965 | 2.7 | 2,657 | 3.5 | 2,019 | 2.5 | 2,190 | 3.7 |

Abbreviations: ICD-10-CM, International Classification of Diseases, 10th Revision, Clinical Modification.
[a] Excludes encounters that received only cause codes for unspecified mechanism (T14.91, X58.X, Y09.X, Y35.9, Y36.89, Y36.90, Y37.90, Y38.80), unspecified activity (Y93.3), and/or unspecified place (Y92.9); 2016 n=2,499, 2017 n=1,305, 2018 n=1,251, 2019 n=1,138.
[b] Incident primary injury diagnoses only. Mechanism, activity, or place of occurrence code.

**TABLE 3.** Distribution of Specified Mechanisms[a] for Incident Injuries, Active Component, U.S. Armed Forces, 2016–2019

| Mechanism[b] | 2016 | | 2017 | | 2018 | | 2019 | |
|---|---|---|---|---|---|---|---|---|
| | No. | % | No. | % | No. | % | No. | % |
| Overexertion[c] | 835 | 0.8 | 19,846 | 16.4 | 23,808 | 18.9 | 26,844 | 19.9 |
| Falls, slips, trips | 24,034 | 23.1 | 22,960 | 18.9 | 23,024 | 18.3 | 25,244 | 18.7 |
| Struck by, against | 22,506 | 21.6 | 22,367 | 18.4 | 22,460 | 17.8 | 23,432 | 17.4 |
| Other specified | 16,732 | 16.1 | 14,867 | 12.3 | 13,829 | 11.0 | 14,568 | 10.8 |
| *Other specified, child or adult abuse* | 7,588 | 7.3 | 6,666 | 5.5 | 5,785 | 4.6 | 6,010 | 4.5 |
| *Other specified, classifiable* | 4,848 | 4.7 | 4,367 | 3.6 | 4,397 | 3.5 | 4,821 | 3.6 |
| *Other specified, foreign body* | 3,628 | 3.5 | 3,498 | 2.9 | 3,276 | 2.6 | 3,384 | 2.5 |
| *Other specified, NEC* | 668 | 0.6 | 336 | 0.3 | 371 | 0.3 | 353 | 0.3 |
| Motor vehicle traffic (MVT) | 11,832 | 11.0 | 11,738 | 9.7 | 12,347 | 9.8 | 12,928 | 9.6 |
| *MVT–occupant* | 9,555 | 9.2 | 9,618 | 7.9 | 10,176 | 8.1 | 10,719 | 8.0 |
| *MVT–motorcyclist* | 1,850 | 1.8 | 1,742 | 1.4 | 1,680 | 1.3 | 1,691 | 1.3 |
| *MVT–pedestrian* | 199 | 0.2 | 169 | 0.1 | 237 | 0.2 | 268 | 0.2 |
| *MVT–pedal cyclist* | 213 | 0.2 | 197 | 0.2 | 235 | 0.2 | 233 | 0.2 |
| *MVT–unspecified* | 14 | 0.1 | 7 | <.1 | 13 | <.1 | 12 | <.1 |
| *MVT–other* | 1 | <.1 | 5 | <.1 | 6 | <.1 | 5 | <.1 |
| Cut, pierce | 8,565 | 8.2 | 9,323 | 7.3 | 9,422 | 7.5 | 10,064 | 7.5 |
| Natural, environmental | 7,822 | 7.5 | 8,330 | 6.9 | 9,369 | 7.4 | 9,548 | 7.1 |
| *Bites and stings, non-venomous* | 3,763 | 3.6 | 4,393 | 3.6 | 5,157 | 4.1 | 5,171 | 3.8 |
| *Bites and stings, venomous* | 2,376 | 2.3 | 2,323 | 1.9 | 2,335 | 1.9 | 2,508 | 1.9 |
| *Natural, environmental other* | 1,683 | 1.6 | 1,614 | 1.3 | 1,877 | 1.5 | 1,869 | 1.4 |
| Poisoning | 3,536 | 3.4 | 3,839 | 3.2 | 3,919 | 3.1 | 3,918 | 2.9 |
| *Poisoning, drug* | 2,268 | 2.2 | 2,461 | 2.0 | 2,690 | 2.1 | 2,584 | 1.9 |
| *Poisoning, non-drug* | 1,268 | 1.2 | 1,378 | 1.1 | 1,229 | 1.0 | 1,334 | 1.0 |
| Other transport | 2,228 | 2.1 | 2,037 | 1.7 | 2,062 | 1.6 | 2,095 | 1.6 |
| Motor vehicle, non-traffic | 1,589 | 1.5 | 1,624 | 1.3 | 1,632 | 1.3 | 1,710 | 1.3 |
| Fire, burn | 1,308 | 1.3 | 1,332 | 1.1 | 1,272 | 1.0 | 1,323 | 1.0 |
| *Hot object, substance* | 1,001 | 1.0 | 1,026 | 0.8 | 997 | 0.8 | 1,053 | 0.8 |
| *Fire, flame* | 307 | 0.3 | 306 | 0.3 | 275 | 0.2 | 270 | 0.2 |
| Other land transport | 812 | 0.8 | 876 | 0.7 | 629 | 0.5 | 767 | 0.6 |
| Pedal cyclist, other | 732 | 0.7 | 797 | 0.7 | 760 | 0.6 | 765 | 0.6 |
| Machinery | 927 | 0.9 | 622 | 0.5 | 566 | 0.4 | 627 | 0.5 |
| Firearm | 348 | 0.3 | 401 | 0.3 | 398 | 0.3 | 434 | 0.3 |
| Pedestrian, other | 180 | 0.2 | 212 | 0.2 | 165 | 0.1 | 189 | 0.1 |
| Suffocation | 92 | <.1 | 114 | 0.1 | 149 | 0.1 | 178 | 0.1 |
| Drowning, submersion | 46 | <.1 | 47 | <.1 | 38 | <.1 | 53 | <.1 |
| Total | 104,124 | 100 | 121,332 | 100 | 125,849 | 100 | 134,687 | 100 |

Abbreviations: No., number; NEC, not elsewhere classified; MVT, motor vehicle traffic; ICD-10-CM, International Classification of Diseases, 10th Revision, Clinical Modification.

[a] Excludes cause codes for unspecified mechanisms (T14.91, X58.X, Y09.X, Y35.9, Y36.89, Y36.90, Y37.90, Y38.80); 2016 n=19,236; 2017 n=13,890; 2018 n=13,151; 2019 n=14,386.

[b] Ordered by 2019 results; main categories bolded, subcategories italicized.

[c] ICD-10-CM external cause code for "Overexertion from strenuous movement or load," X50.0, was not available until Oct. 2016.

significantly ($p < 0.001$), from 16.4% that year to 19.9% in 2019 **(Table 3)**. Overexertion was the leading mechanism of injury in 2018 and 2019. Other frequently coded mechanisms of injury during the 4-year period included "falls / slips / trips" (range: 18.3-23.1%) and "struck by/against" (range: 17.4 -21.6%).

Among external cause codes related to activity **(Table 4)**, the most frequently coded activity associated with injury was running (approximately 20% each year), followed by "Other specified" and "Walking/marching/hiking." The proportion of injuries with activity codes for Walking/marching/hiking increased steadily in the 4-year period, from 7.7% in 2016 to 10.6% in 2019. Frequently coded places of occurrence for injuries **(Table 4)** were "Military training ground," "Other specified places," "Unspecified places in private residences," and "Other specified sports and athletic areas."

For all external cause codes, use of 'Other specified' codes for mechanism[20] (e.g., Other specified child / adult abuse, Other specified foreign body) as well as activity (Y93.83) and place of occurrence (Y92.89) were lower in 2019 compared to 2016 ($p < 0.001$).

**TABLE 4.** Leading Activities[a] and Places of Occurrence[b] Associated with Injuries, Active Component, U.S. Armed Forces, 2016–2019

| | 2016[d] | | 2017[e] | | 2018[f] | | 2019[g] | |
|---|---|---|---|---|---|---|---|---|
| | No. | % | No. | % | No. | % | No. | % |
| Activity[c] | | | | | | | | |
| Running (Y93.02) | 9,985 | 18.5 | 11,721 | 20.2 | 11,444 | 20.4 | 12,556 | 21.1 |
| Other specified activity (Y93.83) | 7,759 | 14.4 | 7,442 | 12.8 | 7,380 | 13.1 | 6,850 | 11.5 |
| Walking, marching, hiking (Y93.01) | 4,136 | 7.7 | 5,058 | 8.7 | 5,195 | 9.2 | 6,298 | 10.6 |
| Basketball (Y93.67) | 4,876 | 9.2 | 5,719 | 9.9 | 5,191 | 9.2 | 5,059 | 8.5 |
| Free weights (Y93.B3) | 2,250 | 4.2 | 2,424 | 4.2 | 2,326 | 4.1 | 2,568 | 4.3 |
| Other involving muscle-strengthening exercises (Y93.B9) | 1,879 | 3.5 | 1,872 | 3.2 | 1,862 | 3.3 | 2,239 | 3.8 |
| American tackle football (Y93.61) | 2,614 | 4.9 | 2,398 | 4.1 | 2,044 | 3.6 | 2,114 | 3.6 |
| Martial arts (Y93.75) | 1,740 | 3.2 | 1,845 | 3.2 | 1,869 | 3.3 | 2,092 | 3.5 |
| Push-ups, pull-ups, sit-ups (Y93.B2) | 1,304 | 2.4 | 1,574 | 2.7 | 1,521 | 2.7 | 1,702 | 2.9 |
| Soccer (Y93.66) | 1,755 | 3.3 | 1,778 | 3.1 | 1,694 | 3.0 | 1,600 | 2.7 |
| Place of occurrence[c] | | | | | | | | |
| Military training ground (Y92.84) | 2,812 | 7.9 | 4,260 | 11.2 | 4,930 | 13.1 | 4,972 | 13.0 |
| Other specified place (Y92.89) | 3,559 | 10.0 | 3,920 | 10.3 | 4,315 | 11.4 | 3,493 | 9.2 |
| Unspecified place in private residence (Y92.009) | 3,519 | 9.9 | 4,136 | 10.9 | 3,724 | 9.9 | 3,476 | 9.1 |
| Other specified sports and athletic area (Y92.39) | 3,373 | 9.5 | 3,372 | 8.8 | 3,061 | 8.1 | 3,098 | 8.1 |
| Unspecified street and highway (Y92.410) | 2,576 | 7.2 | 2,398 | 6.3 | 2,599 | 6.9 | 2,635 | 6.9 |
| Other place on military base (Y92.138) | 1,785 | 5.0 | 2,099 | 5.5 | 1,791 | 4.8 | 2,362 | 6.2 |
| Unspecified place on military base (Y92.139) | 1,159 | 3.3 | 1,245 | 3.3 | 1,242 | 3.3 | 1,770 | 4.6 |
| Other athletic field (Y92.328) | 1,427 | 4.0 | 1,654 | 4.3 | 1,568 | 4.2 | 1,742 | 4.6 |
| Unspecified place in single family (private) house (Y92.019) | 1,347 | 3.8 | 991 | 2.6 | 1,093 | 2.8 | 1,287 | 3.4 |
| Basketball court (Y92.310) | 1,444 | 4.1 | 1,518 | 4.0 | 1,297 | 3.4 | 1,231 | 3.2 |

Abbreviation: No., number.

[a] Excludes Y93.9, "Activity, unspecified" (2016 n=3,540; 2017 n=2,802; 2018 n=2,729; 2019 n=2,125).

[b] Excludes Y92.9 "Unspecified place or not applicable" (2016 n=9,525; 2017 n=8,027; 2018 n=7,388; 2019 n=7,096).

[c] Ordered by 2019 results; top 10 codes for 2019.

[d] 2016, all other specified activities n=15,474 (29% of all specified activities), total specified activities n=53,868; all other specified places n=12,563 (35% of all specified places), total specified places n=35,564.

[e] 2017, all other specified activities n=16,104 (28%), total specified activities n=57,935; all other specified places n=12,518 (33%), total specified places n=38,111.

[f] 2018, all other specified activities n=15,695 (28%); total specified activities n=56,211; all other specified places n=12,121 (32%), total specified places n=37,687.

[g] 2019, all other specified activities n=16,275 (27%), total specified activities n=59,353; all other specified places n=12,059 (32%), total specified places n=38,125.

## Discussion

This is the first comprehensive assessment of ICD-10-CM external cause coding of military electronic injury medical records. Overall, the proportion of injury records with cause coding is small and substantially less than historical military injury hospitalization cause coding rates.[25] More frequent and more specific cause coding is needed in outpatient settings, where the majority (99%) of injury treatment occurs.[9]

Cause coding was more common with acute injuries (S and T codes), compared to overuse injuries (M codes). This is not surprising, given that national injury categorization tools focus on acute injuries only.[21,26] Approximately 75% of service member injuries are due to cumulative microtrauma, however, and such injuries are routinely included in injury definitions by sports and occupational medicine experts.[27] These overuse injuries, which range from joint pain to Achilles tendonitis and stress fractures, are common in physically active populations and result from often preventable factors such as overtraining, over-exertion, repetitive movement, vibration, and prolonged static postures.[27] To effectively address military injuries, cause information is needed for both acute and overuse injuries.

Cause coding was also shown to be more common at military treatment facilities, especially hospitals and medical centers. This may be because larger facilities have resources including medical coders who train providers and audit and code records. Emergency care departments, on average, cause coded a much higher proportion of injury records compared to other clinics, with roughly half of injury-related emergency department injury records receiving a cause code. This was consistent across services, suggesting that processes and staffing in emergency care facilitated cause coding.

While assignment of external cause codes is not mandatory in the U.S. or the MHS, annual ICD-10-CM coding guidelines consistently recommend that providers voluntarily report external cause, given its value for injury research and evaluation of prevention strategies.[8] In addition, the military safety community has recognized the need for injury cause coding to support the systematic identification and mitigation of Department of Defense (DOD) injuries.[3,13] The small proportion of injury records that are cause-coded, however, represents a challenge for leaders, policymakers, safety professionals, researchers, public health scientists, and others interested in data-driven injury prevention, since records do not completely reflect the distributions of mechanisms, activities, and places of occurrence for all injuries, in particular overuse injuries. In addition, use of non-specific or 'Other, specified' cause codes is high, offering minimal to no value for prevention, monitoring, and treatment.

Limitations of this analysis included use of the first 9 diagnoses only, although effects should be minimal, since 99.5% of diagnoses are recorded in the first 9 'DX' fields. An additional limitation was the need to exclude data from 4 military treatment facilities that were the first to transition the MHS GENESIS records system. Exclusion was necessary to minimize effects of data missingness during the analysis period.

In summary, results indicate that relatively few military injury electronic medical records, overall, receive a cause code of any kind. Next steps for DOD leaders and policy-makers include efforts to improve cause coding, considering suggestions offered by the Centers for Disease Control and Prevention (CDC),[28] as well as changes to U.S. military medicine policies, procedures, and contracts to increase injury cause coding. CDC recommendations include integration of cause coding into data standards, development of a toolkit on use of cause codes to set priorities and evaluate injury prevention programs, and creation of guidelines and training to instruct health care providers on injury documentation in medical records.[28] Providers need support, training, and innovative tools to cause code efficiently and accurately. Ultimately, knowledge of causes is a foundation for the reduction of the burden of injuries on the military medical system and sustainment of military medical readiness.

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# Development of a New Fleet Disease and Injury Surveillance Capability Using ESSENCE

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Historically, disease and illness (D&I) surveillance on U.S. Navy vessels relied on weekly data updates and required manual data processing. Established surveillance approaches for fixed military hospitals and clinics were not designed to be applied to the highly mobile populations aboard ships. This paper describes the development of a new surveillance capability through utilization of the Electronic Surveillance System for the Early Notification of Community-based Epidemics (ESSENCE). The pilot program successfully instituted a near real-time D&I surveillance system defined for shipboard operations. Following initial data and system assessment, an operational surveillance strategy was developed and implemented at the Navy's 4 regional Navy Environmental and Preventive Medicine Units responsible for global fleet assets. Despite early implementation challenges, preventive medicine users reported that the fleet ESSENCE system was effective in identifying potential outbreaks, with sufficient efficiency for daily surveillance.

**What are the new findings?**

This new capability using in-theater data in ESSENCE enables unprecedented, near real-time D&I surveillance for the U.S. Navy fleet. While currently targeting gastrointestinal and respiratory illness trends, the infrastructure has flexibility to add new modules in response to fleet and preventive medicine requirements.

**What is the impact on readiness and force health protection?**

High quality D&I surveillance of operational forces by Navy preventive medicine assets accelerates technical support and response to outbreaks and other public health threats. Rapid implementation of appropriate control measures is the key to minimizing the effect of these events on both the force and the mission.

Force protection against public health threats depends on timely, accurate public health surveillance data. A robust and flexible disease and illness (D&I) surveillance system is imperative for the U.S. Department of the Navy, due to its highly mobile population with frequent missions to isolated and resource-limited locations around the globe, confined living conditions aboard ships, and the dynamic nature of diseases.

Historically, D&I surveillance involved labor-intensive, manual methods that produced weeks-long delays in situational awareness.[1-5] U.S. Navy vessels have since adopted electronic health record (EHR) capabilities, allowing more time-efficient D&I surveillance methods. Shipboard medical visits are entered into Armed Forces Health Longitudinal Technology Application-Theater (AHLTA-T) or Shipboard Automated Medical System (SAMS), employing a 'store and forward' model designed for low communication environments; data are stored until internet connectivity is available, at which time they are transmitted to a central data repository, the Theater Medical Data Store (TMDS). With the recent addition of TMDS data into the Department of Defense (DOD)'s Electronic Surveillance System for the Early Notification of Community-based Epidemics (ESSENCE), the Navy and Marine Corps Force Health Protection Command (NMCFHPC) proposed an initiative to advance an automated D&I surveillance capability.

Millions of outpatient medical encounter records and laboratory results are systematically queried using ESSENCE, to detect health events of potential public health significance and support public health investigations.[6] Since 2003, ESSENCE began supporting force health protection by collecting near real-time health surveillance data on U.S. military health system beneficiaries from on-base, fixed location military hospitals and clinics. Beginning in 2017, the Armed Forces Health Surveillance Division (AFHSD) Integrated Biosurveillance Branch (IB) worked to acquire mobile, forward-operating clinical data from the TMDS, structured those data for ESSENCE integration, and collaborated with security experts to mitigate potential risks associated with data access. By October 2022, TMDS data became available to selected ESSENCE users for evaluation and pilot testing and, since June 28, 2024, have been ingested into ESSENCE in batches every 12 hours. This integration of TMDS data with ESSENCE provided the NMCFHPC with an opportunity to improve maritime situational awareness.

This report details the steps taken to develop a timely, accurate, and comprehensive Navy fleet D&I surveillance capability, along with the successes and challenges that will guide further refinement and expansion of this tool.

## Methods

From October 2022 until June 2023, AFHSD-IB and NMCFHPC worked together to develop and test the initial surveillance capability. The implementation plan 1) assessed TMDS data quality and the utility of available ESSENCE analytic tools, 2) developed an initial shipboard surveillance capability for regional surveillance, 3) recommend and implemented ESSENCE system improvements, and 4) tested and evaluated the capability.

### Data Assessment

An initial assessment of ESSENCE TMDS data in January 2023 demonstrated a total of 246 data fields, including many necessary for operational health surveillance, such as patient and reporting unit, demographic fields, clinical notes and vital statistics, laboratory and pharmacy data, discharge diagnosis codes, chief complaints, and D&I category fields. While many fields were sufficiently complete for both surveillance and disease threat characterization, they were often difficult to query due to unstructured formats (i.e., use of free text). The completeness of ship data was evaluated using the Navy Vessel Register.[7] The list of expected ships (excluding inactive ships, those in Navy Sealift Command, and forward medical units not identified as ships) were compared to ships with data recorded in ESSENCE at least once from January 2022 through December 2023.

From January through June 2023, over 75,000 health care encounters on U.S. Navy fleet vessels were captured in ESSENCE. Approximately 81% of expected ships had encounters documented. The distribution of health encounters, by ship size, is shown in **Table 1**.

Data timeliness was assessed based on the difference between the date of the health care encounter and when the data were uploaded into ESSENCE, for those ships with data in ESSENCE **(Table 2)**. An ESSENCE upload date signifies the most recent date a record is updated rather than the date the record was first received, so observed timeliness in **Table 2** may overestimate the true interval. Within 10 days, 78% of clinical encounters were visible in ESSENCE. Encounter data from smaller ships were not as timely as data captured from larger ships.

### System Assessment

NMCFHPC's qualitative review of ESSENCE's functionality and capability revealed several issues that required resolution with the AFHSD-IB ESSENCE team. In some cases, the ESSENCE developers modified the system's functionality to address limitations. Several modifications were implemented to improve user experience and better meet surveillance needs **(Table 3)**. Other issues were addressed through ESSENCE queries designed to minimize data quality limitations.

### Shipboard Surveillance Pilot

NMCFHPC's fleet surveillance methodology for the pilot program involved the creation of dashboards to visually display time series graphs of the query results. A series of graphs were initially generated to determine the best way to aggregate data for ships (e.g., as a function of ship size, geography, mission relevancy, syndrome category) to facilitate efficient data review. Displaying data for a single ship in each time series graph was found to be optimal for ease of data review and interpretation **(Figure 1)**.

Three outcomes of interest were selected to be displayed on dashboards as time series graphs: all daily health care encounters for the past 3 months, weekly gastrointestinal illness encounters for the past year, and weekly respiratory illness encounters for the past year. Ships were divided into 4 geographic areas, representing each of the Navy's 4 regional Navy Environmental and Preventive Medicine Units (NEPMUs), based on home port as indicated in the Naval Vessel Register.[7] Time series graphs for all ships associated with a specific NEPMU (range: 16-73 ships) and specific outcome were displayed on a single dashboard. In the end, over 600 time series graphs were developed to form the final set of 12 total dashboards (with 3 outcomes per NEPMU).

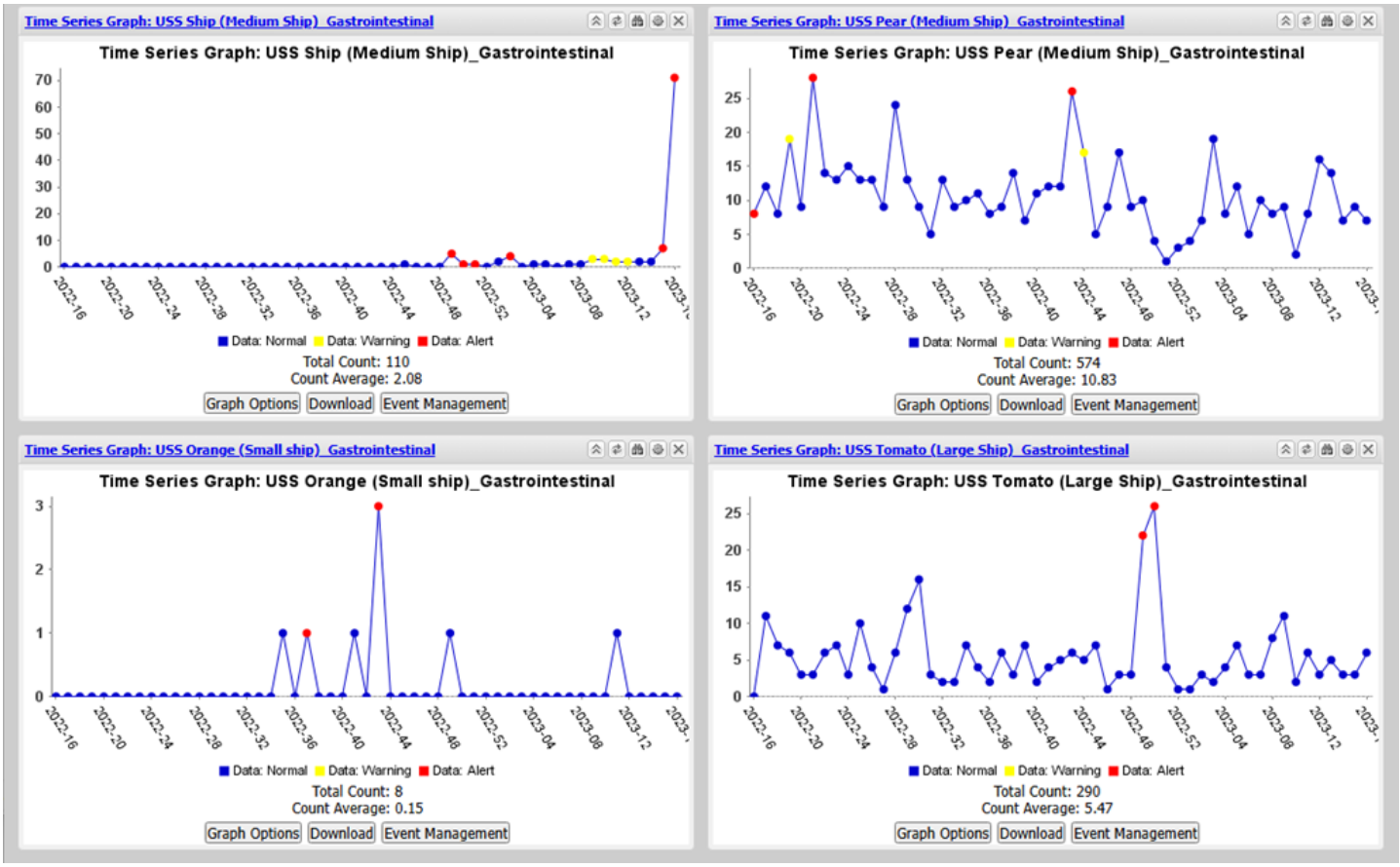
Fleet surveillance was initiated for all 4 NEPMUs from April through June 2023, following individual training and distribution of a companion training guide. Each NEPMU had 1 to 3 users (either environmental health officers, preventive medicine physicians, or preventive medicine technicians) who were tasked with reviewing the dashboards **(Figure 1)** at least twice per week to identify trends that indicated a potential public health concern. When unusual trends were observed, NEPMUs viewed a listing of individual encounter data (clinical notes, demographics, discharge diagnosis, lab results) for a specific date to facilitate their initial public health threat assessment. Findings suggesting a potential outbreak triggered communication between NEPMU and the ship for support.

During the pilot program, 1 NEPMU began closely monitoring a large ship with an apparent gastrointestinal outbreak. Before initiating contact with the ship, a risk assessment was completed within minutes, based solely on the ESSENCE data details. Analysis revealed that most patients had similar symptoms, and before their illness, many patients reported consuming street food during a recent port visit. Norovirus was laboratory confirmed as the etiologic agent. Details were confirmed upon direct communication with the fleet. The ESSENCE gastrointestinal illness dashboard continued to be used for ongoing monitoring of control measure effectiveness

**TABLE 1.** Percentage of Ships with Health Care Encounter Data in ESSENCE by Ship Size, January–June 2023

| Ship category (Population Size) | % of ships |
|---|---|
| Large ships (>= 5000) | 91.0 |
| Medium ships (1000 - 3000) | 100.0 |
| Small ships (<= 500) | 78.0 |

**FIGURE 1.** Time Series Graphs[a] for Gastrointestinal Diseases Reported from Individual U.S. Navy Ships




[a] Within each dashboard, time series graphs represent weekly trends of a single ship's encounters for a specific syndrome category.
Note: ESSENCE alerting algorithms test for unusually high counts compared to what is expected based on the baseline, preceding time period. A yellow alert indicates that the statistical significance (p-value) is less than 0.05, while a red alert indicates that the statistical significance is less than 0.01.

**TABLE 2.** Percentage of Health Encounter Records Received by Time Interval and Ship Size, January–June 2023

| Ship category (Population Size) | <=3 days (%) | <=7 days (%) | <=10 days (%) | <=14 days (%) | <=21 days (%) | <=28 days (%) |
|---|---|---|---|---|---|---|
| Large ships (>=5000) | 67.2 | 78.4 | 83.3 | 87.6 | 91.3 | 93.1 |
| Medium ships (1000 - 3000) | 57.3 | 68.9 | 72.7 | 75.8 | 80.6 | 85.2 |
| Small ships (<=500) | 50.4 | 63.0 | 68.2 | 74.1 | 80.8 | 85.5 |
| Total | 62.1 | 73.6 | 78.4 | 82.7 | 87.3 | 90.2 |

[a] Time intervals were calculated as number of days between encounter date and ESSENCE upload date.

during the outbreak, which took more than 3 weeks to resolve **(Figure 2)**.

Three months after the pilot program was initiated, user responses on the utility of the ESSENCE shipboard dashboards, as an integrated part of routine surveillance at the NEPMU, were collected via electronic survey, administered with Microsoft 365 Forms. Virtual user forums served as a mechanism for gathering additional details on strengths and limitations, developing potential solutions to those limitations, and informing a plan to expand the capability throughout the fleet public health community.

Responses indicated that each NEPMU had at least 1 intermediate or advanced user with prior ESSENCE experience. The frequency of dashboard review varied depending upon ship distribution within a regional area. The NEPMU with the fewest ships reported that dashboard review once a week was sufficient, due to other available surveillance methods; NEPMUs with more ships reported reviewing their dashboards daily. NEPMUs reported being able to easily identify concerning trends

using the dashboards within 15-30 minutes, with additional time needed when a review of underlying data was necessary. Users also noted timely data updates for many ships within ESSENCE, particularly ships with larger populations. Notable challenges included reports of the system being slow at times, and low numbers of encounters that complicated trend detection and quick risk assessments. Users also reported that data interpretation was complicated by a lack of understanding of various EHR data entry challenges aboard ships, such as software technical issues, paper record use, and intermittent electronic communication access.

**TABLE 3.** Observations, Findings, and Associated Actions for Development of Fleet Surveillance Capability Using ESSENCE TMDS Data

| Observations and Findings | Associated Actions |
|---|---|
| Multiple records (rows) per encounter for multiple lab test results for same patient, resulting in inflated health encounter counts | Laboratory data for a single encounter were concatenated ("flattened") into a single row |
| Three primary D&I fields could be used to develop queries | D&I field based on ICD-10-CM code was selected to develop queries, given high level of completeness and alignment with clinical details |
| Some ships (26%) used outdated ICD-9-CM codes for discharge diagnosis categorization | D&I field based on chief complaints was selected to develop queries for ships using ICD-9-CM codes |
| Intermittent data gaps for time series graphs of shipboard health care encounters complicated data interpretation | Time series graphs with all health care encounters were included in surveillance dashboards for review, in addition to specific syndromes, to enable monitoring of incoming data consistency |
| Lack of standard naming convention for text field containing ship name | Queries were developed to account for name variations |
| Inability to directly query data field containing ship name | ESSENCE query options were updated to enable direct free text queries of the field |
| Lack of general query that captured all respiratory illness, a necessity for small population surveillance | Built-in query was developed to capture a broad range of acute respiratory illnesses |
| More than 200 data fields possible for a single health care encounter, complicating record reviews | ESSENCE was updated so data fields were rearranged in order of epidemiological importance, and irrelevant fields were hidden |

Abbreviations: ESSENCE, Electronic Surveillance System for the Early Notification of Community-based Epidemics; TMDS, Theater Medical Data Store; D&I, disease and injury; ICD-10-CM, International Classification of Diseases, 10th Revision, Clinical Modification; ICD-9-CM, International Classification of Diseases, 9th Revision, Clinical Modification.

## Discussion

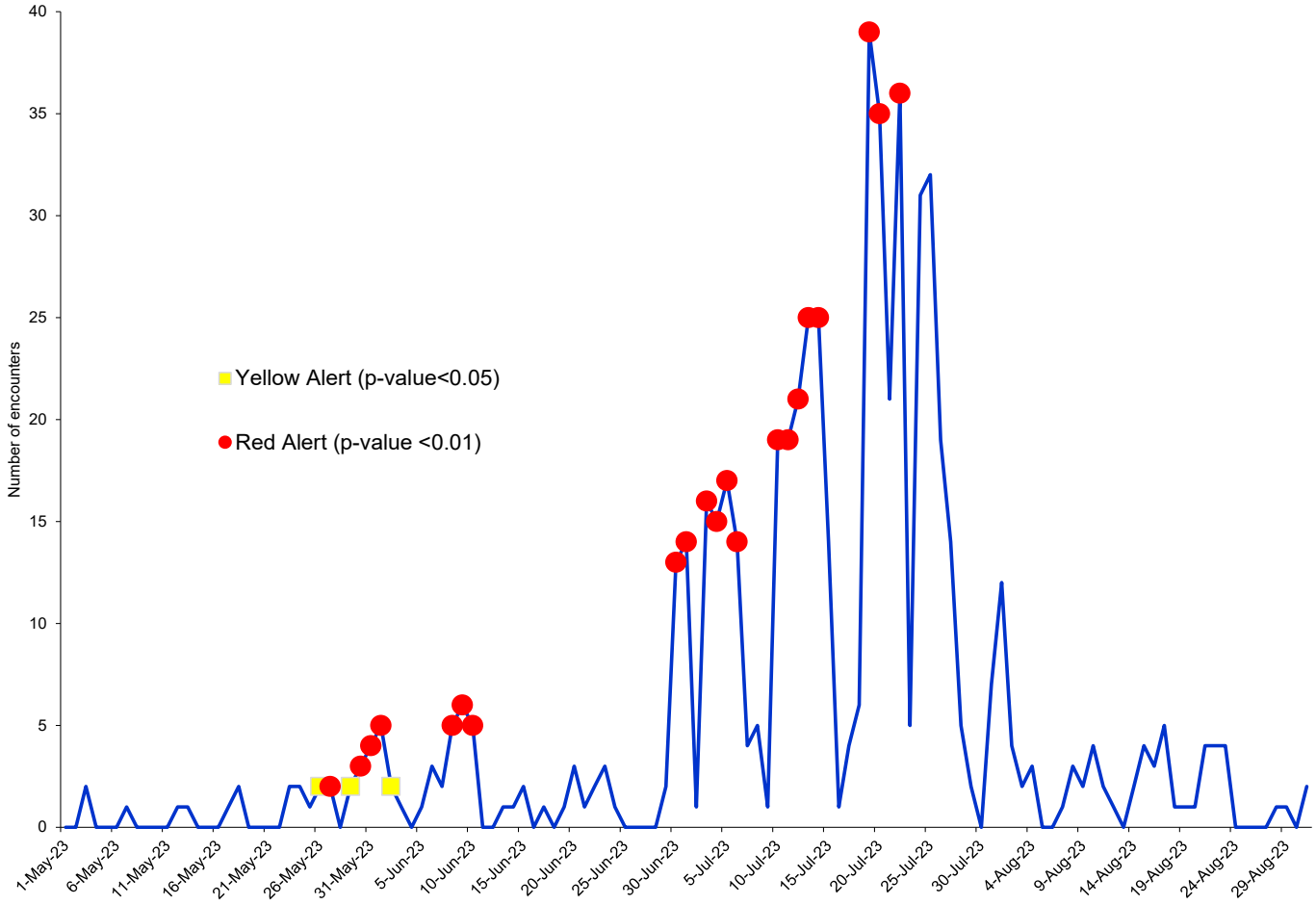
This report recounts a major advancement in timely and reliable public health surveillance for ships, made possible through use of ESSENCE TMDS data. Surveillance methodology using ESSENCE for on-base military hospitals and clinics could not be applied to fleet surveillance due to differences in both data structure and populations served (i.e., smaller, healthier, closed populations aboard ships).[8] This pilot program developed, within 3 months, a new capability to monitor mobile populations ranging from 50 to 5,000 people that addressed their complexities and unique challenges.

In the past, D&I surveillance involved collecting and compiling reports from individual ships, a time-intensive multi-step process, but now data are automatically collected and available every 12 hours, a major advancement. This new capability supports expeditious and efficient data review, facilitates communication between the fleet and preventive medicine experts, and contributes to disease outbreak identification and containment.

Initial data assessments for this pilot program revealed remarkably higher levels of completeness and timeliness compared to legacy D&I surveillance strategies.[4,5,9] Nearly three-quarters of encounters for ships (with all sizes combined) were visible within 7 days, a notable improvement over the weeks-long delays with earlier methods. These gains in data timeliness and completeness were achieved without requiring additional time or effort from a ship's medical staff. Nonetheless, the delay between the health care encounter date and the ESSENCE upload date is a potential limitation that may require further study to improve this surveillance capability.

Several challenges had to be overcome for this pilot program's success. Lack of standardized discharge diagnostic code usage was problematic, likely due to lack of synchronization of updates to shipboard information technology. For ships still using International Classification of Diseases, 9th Revision, Clinical Modification codes, queries were developed using chief complaint text. The field containing the ship name was unstructured (i.e., utilized free text) and names were not entered using a single standardized naming convention, presenting another major barrier. Hundreds of queries had to be developed and refined to obtain reliable results for ship-specific data. The final set of queries were complex, as a result of accounting for various naming patterns observed in the data. Periodic data review and revisions will be necessary to ensure queries continue to reliably capture ship data as expected. Ongoing, collaborative engagement between military surveillance experts (AFHSD-IB

**FIGURE 2.** Gastrointestinal Health Encounters Onboard a U.S. Navy Ship Experiencing an Outbreak, May 2023–August 2023




and NMCFHPC), the ESSENCE developers, and theater data owners was essential for the success of this pilot program.

Two major challenges remain. The first challenge is the need to develop more efficient methods of surveilling shipboard populations with low numbers of health care encounters. Medical departments on smaller ships may only see 5-15 patients a week, making the determination of daily trends for specific outcomes (e.g., gastrointestinal illness, respiratory illness) difficult. The surveillance of all health care encounters, instead of individual syndromes, was evaluated as a solution but was further complicated by large numbers of periodic administrative encounters that interfered with the detection of potential public health threats. The second challenge involves intermittent data gaps in ship time series graphs, which can interfere with data trend interpretation. Anecdotal evidence suggests that these gaps are related to routine shipboard operations (e.g., maintenance, pulling into port). Geographic-specific operations or EHR system technical limitations may also lead to temporary use of paper medical records. More study is needed to fully assess these occurrences and develop approaches to improve the reliability of fleet surveillance.

This new capability provides an extraordinary opportunity to expand and improve operational fleet D&I surveillance. The methods and framework developed by this pilot program can be further adapted and expanded for surveillance of other health events of interest, such as injuries and mental illnesses. Additionally, the availability of near real-time data that are accessible by public health responders is ideal not only for threat detection, but reviewing and pursuing data quality improvements. Although mechanisms may differ, expansion efforts are being pursued. ESSENCE TMDS data were used for surveillance during a military exercise, Exercise Talisman Sabre 2023, and provided effective, timely public health information beyond outbreak-specific surveillance. Near real-time D&I surveillance promotes enhanced situational awareness at regional commands as well as headquarters, facilitating development of operational plans that can mitigate potential public health threats as early as possible.

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*Disclaimers*

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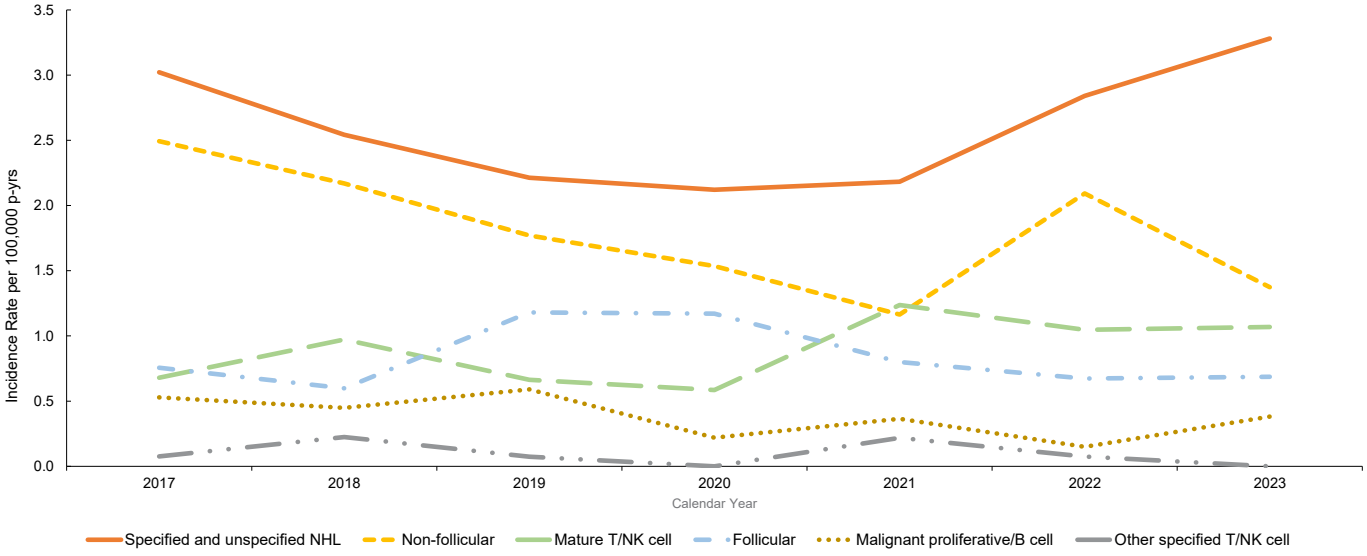
*Surveillance Snapshot*

# Non-Hodgkin Lymphoma Incidence in Active Component U.S. Service Members, 2017–2023

*Scott J. Russell, MPH; Sithembile L. Mabila, PhD, MSc*

**FIGURE.** Non-Hodgkin Lymphoma Subtype and Overall Rates Among Active Component U.S. Service Members, 2017–2023




Lymphomas are defined into 2 categories: Hodgkin lymphomas, which present with Reed-Sternberg cells, and non-Hodgkin lymphomas (NHLs), which do not.[1] While the narrowly-defined Hodgkin lymphomas, which comprise about 10% of cases, tend to respond well to treatment, the prognoses for NHLs, which account for 90% of lymphomas, vary widely based on a cancer's subgroup within its greater designation.[2] Variable treatment successes can be partly explained by difficulties in diagnosis and a wider range of tumor aggression between subtypes.[3]

NHL is 1 of the 10 most diagnosed cancers in the U.S. for both men and women. Generally diagnosed after the age of 60,[3-5] the incidence rate (IR) of all NHL within the U.S. general population in 2021 was 22.1 per 100,000 persons in men and 15.2 in women[6]; for those under age 50 years, rates declined to 5.3 and 3.9, respectively.[7] A recent study suggests that some cancer rates in military personnel differ from the general population, but no prior analyses nor determinations of historical rates of NHL within the U.S. military population exist.[7]

This analysis utilized an updated case definition developed by the Armed Forces Health Surveillance Division (AFHSD), based on consultation with subject matter experts and previous literature, which divides the International Classification of Diseases, 10th Revision (ICD-10) codes for NHL into 6 subgroups.[8] Follicular, non-follicular, and mature T/NK cell lymphomas **(Table)** refer to specific cancer subgroups, while the other cancer types denote broader subgroup categories.[8] These definitions were applied to the data in the Defense Medical Surveillance System (DMSS)'s inpatient and outpatient records from January 2017 through December 2023 for active component service members (ACSMs). An incident case was defined as 1 qualifying inpatient diagnosis in the first diagnostic position, a diagnosis in the second diagnostic position with a qualifying treatment code in the first diagnostic position, or 3 outpatient visits with qualifying diagnoses within 90 days of one another.[8] Only the first lifetime diagnosis was considered incident. The total person time for all eligible ACSMs was then calculated to define the incidence rates for each subgroup **(Table)**.

A total of 621 incident cases in this study contributed to the overall IR of 6.6 cases per 100,000 person-years (p-yrs). The number and IR were higher among men (n=535, IR 6.8 per 100,000 p-yrs) compared to women (n=86, IR 5.39 per 100,000 p-yrs), and a majority of men (n=327) were of non-Hispanic White race or ethnicity (data not shown). These results are consistent with the population distribution of the U.S. military, which is majority non-Hispanic White male, and do not suggest any race-based effects on lymphoma diagnosis.

Specified and Unspecified NHL had the highest overall IR (2.6 per 100,000 p-yrs) over the surveillance period **(Figure)**. There is a modest increase in IR, especially among Specified and Unspecified NHL diagnoses over the 7-year surveillance period **(Figure)**. These rates are far lower than the non-age stratified reported national rates—19.0 per 100,000 for men and 15.8 for women—because the military population is much younger, with most cases occurring between ages 20 and 45 years, with only 1 in the older than age 60 years demographic (data not shown). Overall, lymphoma rates were low among ACSMs during the surveillance period.

**TABLE.** Lymphoma Subtype Rates[a] Among U.S. Active Component Service Members, 2017–2023

| Cancer Type | 2017 | | 2018 | | 2019 | | 2020 | | 2021 | | 2022 | | 2023 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | No. | IR | No. | IR | No. | IR | No. | IR | No. | IR | No. | IR | No. | IR |
| Specified and unspecified NHL | 40 | 3.0 | 34 | 2.5 | 30 | 2.2 | 29 | 2.1 | 30 | 2.2 | 38 | 2.8 | 43 | 3.3 |
| Non-follicular | 33 | 2.5 | 29 | 2.2 | 24 | 1.8 | 21 | 1.5 | 16 | 1.2 | 28 | 2.1 | 18 | 1.4 |
| Mature T/NK cell | 9 | 0.7 | 13 | 1.0 | 9 | 0.7 | 8 | 0.6 | 17 | 1.2 | 14 | 1.0 | 14 | 1.1 |
| Follicular | 10 | 0.8 | 8 | 0.6 | 16 | 1.2 | 16 | 1.2 | 11 | 0.8 | 9 | 0.7 | 9 | 0.7 |
| Malignant proliferative/B cell | 7 | 0.5 | 6 | 0.4 | 8 | 0.6 | 3 | 0.2 | 5 | 0.4 | 2 | 0.1 | 5 | 0.4 |
| Other specified T/NK cell | 1 | 0.1 | 3 | 0.2 | 1 | 0.1 | 0 | 0.0 | 3 | 0.2 | 1 | 0.1 | 0 | 0.0 |

Abbreviations: No., number; IR, incidence rate; NHL, non-Hodgkin lymphoma.
[a] Rates per 10,000 person-years.

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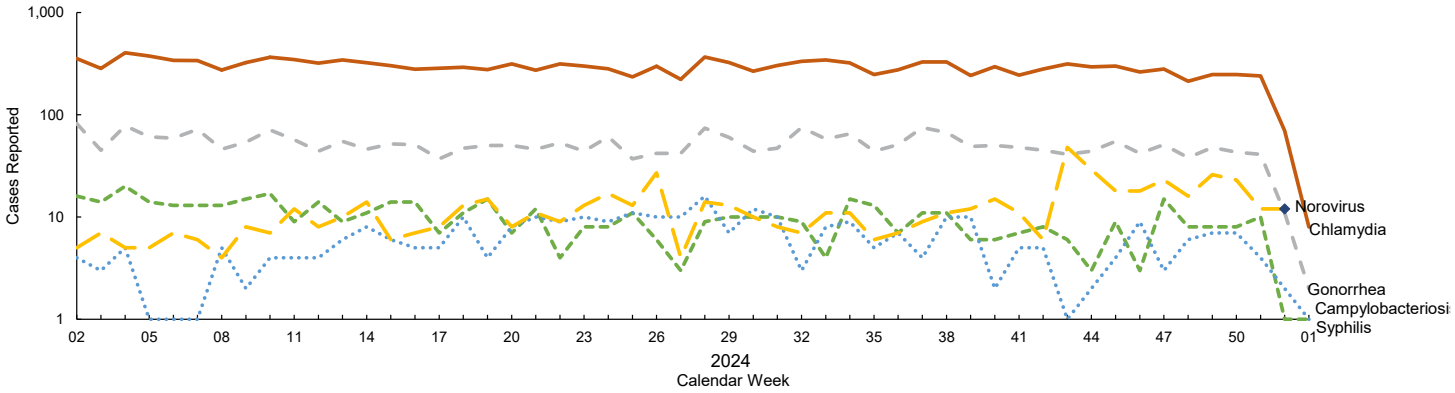
# Reportable Medical Events at Military Health System Facilities Through Week 1, Ending January 4, 2025

*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 (JANUARY 13, 2024 - JANUARY 4, 2025)




Abbreviation: RMEs, reportable medical events.

[a]Cases are shown on a logarithmic scale.

Note: No norovirus cases were reported during week 1, which covers the period from Dec. 29-31.

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 (December 2024) 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

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**TABLE.** Reportable Medical Events, Military Health System Facilities, Week Ending January 4, 2025 (Week 1)[a]

| Reportable Medical Event[b] | Active Component[c] | | | | | MHS Beneficiaries[d] |
|---|---|---|---|---|---|---|
| | November 2024 | December 2024 | YTD 2024 | YTD 2023 | Total 2023 | December 2024 |
| | No. | No. | No. | No. | No. | No. |
| Amebiasis | 3 | 1 | 15 | 15 | 15 | 0 |
| Arboviral diseases, neuroinvasive and non-neuroinvasive | 0 | 0 | 3 | 2 | 2 | 0 |
| Brucellosis | 0 | 0 | 1 | 0 | 0 | 0 |
| COVID-19-associated hospitalization and death[e] | 1 | 2 | 42 | 113 | 113 | 24 |
| Campylobacteriosis | 22 | 22 | 319 | 270 | 270 | 5 |
| Chikungunya virus disease | 0 | 1 | 1 | 2 | 2 | 0 |
| *Chlamydia trachomatis* | 1,106 | 838 | 15,281 | 17,510 | 17,510 | 132 |
| Cholera | 0 | 0 | 3 | 4 | 4 | 0 |
| Coccidioidomycosis | 1 | 4 | 48 | 36 | 36 | 1 |
| Cold weather injury[f] | 17 | 17 | 172 | 152 | 152 | N/A |
| Cryptosporidiosis | 1 | 2 | 81 | 67 | 67 | 3 |
| Cyclosporiasis | 0 | 0 | 11 | 15 | 15 | 0 |
| Dengue virus infection | 1 | 0 | 12 | 7 | 7 | 1 |
| *E. coli*, Shiga toxin-producing | 9 | 12 | 91 | 69 | 69 | 2 |
| Ehrlichiosis/anaplasmosis | 0 | 0 | 1 | 28 | 28 | 0 |
| Giardiasis | 5 | 3 | 98 | 78 | 78 | 6 |
| Gonorrhea | 192 | 148 | 2,701 | 2,763 | 2,763 | 24 |
| *Haemophilus influenzae,* invasive | 0 | 0 | 3 | 1 | 1 | 2 |
| Hantavirus disease | 0 | 0 | 0 | 2 | 2 | 0 |
| Heat illness[f] | 28 | 4 | 1,275 | 1,254 | 1,254 | N/A |
| Hepatitis A | 0 | 0 | 7 | 7 | 7 | 0 |
| Hepatitis B, acute and chronic | 6 | 4 | 102 | 156 | 156 | 4 |
| Hepatitis C, acute and chronic | 0 | 1 | 30 | 52 | 52 | 2 |
| Influenza-associated hospitalization[g] | 0 | 8 | 53 | 29 | 29 | 20 |
| Lead poisoning, pediatric[h] | N/A | N/A | N/A | N/A | N/A | 8 |
| Legionellosis | 1 | 0 | 5 | 5 | 5 | 0 |
| Leishmaniasis | 0 | 0 | 0 | 1 | 1 | 0 |
| Leprosy | 1 | 0 | 1 | 2 | 2 | 0 |
| Leptospirosis | 0 | 0 | 0 | 4 | 4 | 0 |
| Lyme disease | 8 | 0 | 100 | 70 | 70 | 2 |
| Malaria | 0 | 3 | 21 | 28 | 28 | 0 |
| Meningococcal disease | 0 | 0 | 1 | 4 | 4 | 0 |
| Mpox | 1 | 0 | 13 | 5 | 5 | 0 |
| Mumps | 0 | 0 | 0 | 0 | 0 | 4 |
| Norovirus | 91 | 79 | 635 | 420 | 420 | 63 |
| Novel and variant Influenza | 0 | 0 | 0 | 0 | 0 | 1 |
| Pertussis | 11 | 1 | 36 | 15 | 15 | 21 |
| Post-exposure prophylaxis against Rabies | 52 | 33 | 593 | 598 | 598 | 42 |
| Q fever | 0 | 0 | 2 | 2 | 2 | 0 |
| Rubella | 0 | 0 | 0 | 2 | 2 | 0 |
| Salmonellosis | 15 | 7 | 156 | 129 | 129 | 18 |
| Schistosomiasis | 1 | 0 | 1 | 0 | 0 | 0 |
| Shigellosis | 3 | 4 | 53 | 59 | 59 | 0 |
| Spotted Fever Rickettsiosis | 1 | 0 | 22 | 31 | 31 | 0 |
| Syphilis (all) | 36 | 27 | 513 | 930 | 930 | 9 |
| Toxic shock syndrome | 0 | 0 | 2 | 2 | 2 | 0 |
| Trypanosomiasis | 1 | 0 | 4 | 1 | 1 | 0 |
| Tuberculosis | 1 | 0 | 5 | 12 | 12 | 0 |
| Tularemia | 0 | 0 | 1 | 1 | 1 | 0 |
| Typhoid fever | 0 | 0 | 1 | 2 | 2 | 0 |
| Typhus fever | 1 | 0 | 2 | 3 | 3 | 1 |
| Varicella | 2 | 2 | 16 | 13 | 13 | 2 |
| Zika virus infection | 0 | 0 | 1 | 0 | 0 | 0 |
| Total case counts | 1,618 | 1,223 | 22,534 | 24,971 | 24,971 | 397 |

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

[a] RMEs reported through the DRSi as of Jan. 05, 2025 are included in this report. RMEs were classified by date of diagnosis or, where unavailable, date of onset. Monthly comparisons are displayed for the period of Nov. 1, 2024–Nov. 30, 2024 and Dec. 1, 2024–Dec. 31, 2024. YTD comparison is displayed for the period of Jan. 1, 2024–Dec. 31, 2024 for MHS facilities. Previous year counts are provided as the following: previous YTD, Jan. 1, 2023-Dec. 31, 2023; total 2023, Jan. 1, 2023–Dec. 31, 2023.

[b] RME categories with 0 reported cases among active component service members and MHS beneficiaries for the time 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 included the following: 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 cases reported after case definition update on May 4, 2023. Includes only cases resulting in hospitalization or death. Does not include cases of hospitalization or death reported under the previous COVID-19 case definition.

[f] Only reportable for service members.

[g] Influenza-associated hospitalization is reportable only for individuals under 65 years of age.

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

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