

**Report Update:**

**Description of Joint Base Pearl Harbor-Hickam DoD-affiliated Housing Residents' Medical Encounters Related to the JP-5 Release, 01 January 2021 – 30 November 2022**

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Defense Centers for Public Health-Portsmouth

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## Executive Summary

This updated report examines medical visit coding data on DoD-affiliated families living in Joint Base Pearl Harbor-Hickam (JBPHH) housing identified in the Defense Occupational and Environmental Health Readiness System Incident Report (DOEHRS IR) for the Red Hill JP-5 (Jet Propellant) fuel release. It assesses the number of occasions individuals presented to a Department of Defense (DoD) Health Care Provider (HCP) or a TRICARE funded HCP that documented an International Classification of Diseases, 10th Revision (ICD-10) code representing a diagnosis of interest that could be related to JP-5 exposure. This population-based report is based on administrative coding data, cannot substantiate or confirm any diagnoses and cannot establish or prove any causal connection of symptoms or diagnoses to actual or potential exposure to JP-5.

DOEHRS is a DoD system of record that allows groups (cohorts) of DoD-affiliated personnel who may have experienced a defined environmental exposure during a defined time period to be documented and tracked over time. The DOEHRS IR for Red Hill contained 27,797 people identified as residing or working at JBPHH at the time of the JP-5 fuel release into its water system on 20 November 2021 (the Red Hill Cohort). Non-DoD-affiliated individuals were not included in this analysis because DCPH-P does not have access to non-DoD-affiliated medical data.

This updated report expands the surveillance period to 11 months prior to and 12 months after the release event. Medical visit records between January 2021 and November 2022 in the DoD data systems on members of the Red Hill Cohort were queried from the Military Health System (MHS) and purchased care data systems to analyze for conditions and symptoms that may be consistent with JP-5 exposure.<sup>1,2</sup>

- 27,797 total DoD-affiliated members were identified in the Red Hill Cohort at the time of this surveillance analysis:
  - 7,473 (26.8%) Cohort members were identified with at least one medical diagnosis of interest after the release event.
  - 6,850 (24.6%) Cohort members had their first medical visit for at least one diagnosis of interest after the release event; some had a different diagnosis of interest before the release event.
  - 820 (2.9%) of the Cohort had their first medical visit with a diagnosis of interest after 20 November 2021 and at least 2 additional visits for the same diagnosis through the end of the surveillance period of this report.
- Medical visits coded within the Central Nervous System category peaked the week of 05 December 2021 and returned to previous levels the following week.
- Medical visits coded within the Gastrointestinal System category peaked the week of 28 November 2021 and returned to previously observed levels in late December 2021.
- Medical visits coded within the Toxic Effects category peaked the week of 05 December 2021 and remained elevated through March 2022 before returning to previously observed levels. This may be attributed to the 28 November 2021 Hawai'i Department of Health advisory for medical providers to utilize these codes to improve documentation consistency and tracking in the medical records.

## Purpose

This report utilizes administrative medical coding data, as a surrogate for population-based health care utilization of the 27,797 people identified in the updated Defense Occupational and Environmental Health Readiness System Incident Report (DOEHRS IR) known as the Red Hill Cohort. The goal is to assess the trends in visits for diagnoses of interest<sup>1,2</sup> (Table A1) that includes a baseline assessment eleven months prior to the release on 20 November 2021 as compared to utilization after the release.

## Background

On 28 November 2021, the Hawai'i Department of Health (DOH) and the Hawai'i Poison Center began receiving reports of a fuel-like taste, odor, and sheen in the drinking water at JBPHH.<sup>3</sup> This was later attributed to a release of JP-5 fuel at the Red Hill Bulk Fuel Storage facility on 20 November 2021 (the release event).<sup>4</sup> U.S. Navy water system users residing in Joint Base Pearl Harbor-Hickam (JBPHH) housing were impacted by the contaminated drinking water<sup>5</sup> and were provided alternative housing. The Commander, U.S. Pacific Fleet, requested the establishment of a DOEHRS IR to document the potential exposure period and provide a repository for Department of Defense (DoD)-affiliated beneficiaries potentially affected by exposure to JP-5 fuel in the JBPHH drinking water system.<sup>6</sup>

DOH declared the water for the first of 19 affected zones safe to drink on 14 February 2022 and by 18 March 2022 safe drinking water was restored to all residential zones served by the Navy's water system.<sup>3</sup> On 12 January 2023, the Navy reported the most recent analysis showed drinking water from the 19 Navy water distribution zones continued to meet U.S. Environmental Protection Agency (EPA) and DOH standards (see Figure A1).<sup>7</sup>

## JP-5 Fuel

JP-5 fuel is a kerosene-based fuel used in military aircraft and is mostly Total Petroleum Hydrocarbons (TPH) diesel range organics.<sup>8</sup> JP-5 is a colorless liquid that is flammable and smells like kerosene.<sup>9</sup> JP-5 is made from chemical compounds called hydrocarbons, which are found naturally in the earth as crude oil. Hydrocarbons are compounds that contain only carbon and hydrogen. The chemicals in JP-5 can enter the body through the lungs (inhalation), digestive tract (ingestion), or skin (dermal).

## Health Effects Associated with JP-5

The health effects of JP-5 depend on the amount, type, route of exposure (inhalation, ingestion, or dermal contact), and duration.<sup>2</sup> Literature describing the short-term and long-term effects of exposure by any combination of ingestion, inhalation, or dermal absorption of hydrocarbon products like JP-5 is limited.<sup>1,2</sup> However, based on current data, the Hawai'i DOH determined

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“people exposed to contaminated drinking water in this incident are not expected to experience long-term health effects.”<sup>1,2</sup> Symptoms of JP-5 exposures have been associated with cough, shortness of breath, skin irritation, eye irritation, headache, fatigue, dizziness, and GI complaints (cramping, nausea, vomiting, or diarrhea).<sup>2,10,11</sup> These symptoms fall into six broad ICD-10 diagnostic categories used in this report that include Central Nervous System (CNS), Respiratory, Gastrointestinal (GI), Skin, Mucous Membranes, and Toxic Effects.

This report’s data are limited to ICD-10 diagnoses only as routine chemical screening (biological monitoring) was not recommended per DOH-Interagency guidance<sup>11</sup> because available blood and urine testing cannot:

- Reliably indicate exposure to JP-5 jet fuel in drinking water
- Determine if presenting symptoms are from exposure to petroleum hydrocarbons in drinking water
- Predict potential future health effects
- Help direct management of patient’s symptoms or clinical condition

## Methods

The DOEHRs IR for Red Hill contained 28,246 people at the time of this report and included DoD-affiliated military housing residents (including Coast Guard) at JBPHH, temporary additional duty (TAD)/temporary duty travel (TDY), visitors, and base workers at the time of the JP-5 fuel release into its water system on 20 November 2021. Individuals were excluded from the analysis if military health system data were not available (n=449) leaving 27,797 DoD-affiliated individuals in this analysis. The DOEHRs IR roster of the Red Hill Cohort included the DoD identification number (DoD ID) for these individuals and was used to establish the population in this surveillance report.

This report examines the health care visits to a DoD or TRICARE authorized DoD health care provider (HCP) where the International Classification of Diseases, 10<sup>th</sup> Revision (ICD-10) code matched a diagnosis of interest potentially related to JP-5 exposure in the Red Hill Cohort. Since the exposure intensity (the level of exposure at the tap in each residence) was unknown, there was no way to demonstrate objective impacts at the level of the individual. However, analyzing medical visits at a population level may be used as a surrogate to assess the potential number of individuals in a population impacted by a given event.

All medical records for Military Health System (MHS) direct care (patients seen by MHS providers) and TRICARE claims for purchased care (patients seen by non-MHS providers) at any location with a medical visit date between 01 January 2021 and 30 November 2022, for diagnoses listed in

Table A1 were collected, including all ambulatory and inpatient medical records. The data sources were:

- Comprehensive Ambulatory Professional Encounter Record (CAPER)
- Standard Inpatient Data Record (SIDR)
- GENESIS Episodic Encounter Table
- GENESIS Admissions Table
- TRICARE Encounter Data Non-Institutional (TED-NI) (ambulatory)
- TRICARE Encounter Data Institutional (TED-I) (inpatient)

The diagnoses listed in Table A1 used specific ICD-10 diagnostic codes identified in provider evaluation and treatment guidance from the DOH<sup>1</sup> and a DHA Public Health Armed Forces Health Surveillance Division syndromic surveillance report.

### Diagnoses of interest potentially related to JP-5 exposure

The Red Hill Bulk Fuel Storage release event occurred on 20 November 2021<sup>12</sup> and the first reported health complaint of contaminated drinking water occurred on 28 November 2021.<sup>3</sup> This report analyzed medical visit data for this population starting from the date of the event, eight days prior to the first reported health complaint. The diagnoses of interest were symptoms that could be caused by JP-5 exposure.<sup>1,2</sup> Acute symptoms develop and resolve in a short period of time (weeks not months). A pre-event baseline referred to as Period 1, was established with visit data from 01 January 2021 to 19 November 2021 to provide a history of an individual's medical visit diagnoses. Data was examined from 20 November 2021 to 30 November 2022 to identify visit trends after the event and referred to as Period 2.

The Defense Health Agency (DHA) requires at least two medical visits to establish the presence of any given condition. During Period 2, patients were classified as being Screened or having Multiple Visits. For this analysis, Screened refers to individuals seeking a health assessment from a clinical provider. Screened patients had one or two visits for the same diagnosis whereas patients with Multiple visits had  $\geq 3$  visits for the same diagnosis.

For each diagnosis, three subcategories of patients were created for this analysis:

- Screened
  - New Screened Patients: had 1 or 2 visits for a diagnosis of interest during Period 2; however, they had no visits for that diagnosis during Period 1
- Multiple Visits
  - New Patients: had multiple visits for care for the same diagnosis ( $\geq 3$  visits) in Period 2 *and* 0-2 visits for the same diagnosis during Period 1
  - Pre-established Patients: had multiple visits for care for the same diagnosis after the event ( $\geq 3$  visits) *and*  $\geq 3$  visits for the same diagnosis during Period 1

## Results

There were 28,246 individuals included in the DOEHS IR roster of which 449 individuals had no matching record in MHS Mart (M2), resulting in 27,797 people included in this review. The 449 individuals without military health system data were not included in this report.

### Cohort Demographics

Demographics within the Red Hill Cohort are displayed in Table A2. Among the cohort, 51.6% (n=14,351) were dependents of active-duty Service members and 41.7% (n=11,579) were affiliated with the Navy. The majority of the cohort were between 18 and 44 years old (59.1%), with 32.4% under the age of 18.

Within the Red Hill Cohort, 27% (n=7,473) had at least one visit for a diagnosis of interest (see Figure A3) following the release event. Of the total Cohort (N=27,797), 820 patients (2.9%) were New Patients that had Multiple Visits for the same diagnosis.

### Symptoms, Complaints, and Health Concerns of JP-5 Exposure

The diagnoses of interest fall under one of six broader ICD10 diagnostic categories to include Central Nervous System (CNS), Respiratory, Gastrointestinal (GI), Dermatological, Mucous Membranes, and Toxic Effects. Figure A4 illustrates the difference in the number of total patients between Period 1 and Period 2 for these six diagnostic categories. Numbers were annualized to correct for the different observation lengths of Period 1 and Period 2. The overall number of patients with CNS and GI diagnoses declined from Period 1 to Period 2 by 6.7% and 11.2%, respectively, while patients seen for Dermatological symptoms remained stable over the two periods. The number of patients seen for symptoms related to the Mucous Membranes and Respiratory systems increased from Period 1 to Period 2 by 26.3% and 11.8%, respectively. The number of patients with a Toxic Effects diagnosis reflected the greatest increase from Period 1 to Period 2 and increased by over 100%.

Table A3 shows the number of patients with a diagnosis of interest documented during Period 2 stratified by age group and diagnosis. One patient may have multiple diagnoses and therefore the sum of patients in this table is greater than the number of distinct individuals (n=7,473) who received care as shown in Figure A5. The majority of diagnoses were observed in patients between the ages of 25 to 44. The most frequently documented diagnoses were cough (n=1,894), headache (n=1,226), unspecified abdominal pain (n=1,034), migraine (n=856), rash (n=832), lethargy/fatigue (n=766), diarrhea (n=630), and dermatitis (n=628); 78% of individuals with a diagnosis of interest were diagnosed with at least one of these symptoms. The distribution of diagnoses by age group during Period 1 was similar to Period 2.

Figure A5 shows the age distribution for individuals who received any diagnosis of interest in Period 2. Age distribution in this group mirrors the distribution in the cohort overall. Of the patients with one or more diagnosis of interest, those younger than 18 accounted for 33.5% (n=2,500) and those aged 18-44 accounted for 57% (n=4,223).

Table A4 provides an overview of the patients seen for medical care during Period 2. Results are stratified by Patients with Multiple Visits versus Screened Patients for diagnoses of interest. The majority of patients did not require multiple visits for a given diagnosis. The most common diagnoses for patients with Multiple Visits were migraine (n=271), cough (n=178), unspecified abdominal pain (n=116), headache (n=90), gait disturbances (n=87), shortness of breath (n=87), dizziness (n=77), and lethargy/fatigue (n=71); 76% of individuals with multiple visits for a diagnosis of interest were diagnosed with at least one of these symptoms. Of patients with Multiple Visits for a migraine diagnosis, 44% had at least three visits with a migraine diagnosis prior to the release event.

For most diagnoses observed in Period 2, the median number of visits for New Patients with Multiple Visits was lower than the median number of visits for Pre-established Patients, particularly for concentration, vomiting, and lower abdominal pain. The change in the median number of monthly visits by Pre-established patients was not statistically significant from Period 1 to Period 2 [Wilcoxon paired test, p=0.2788 (data not shown)].

The most common diagnoses for Screened Patients, were cough (n=1,716), headache (n=1,136), unspecified abdominal pain (n=918), rash (n=806), and lethargy/fatigue (n=695). On average, 88% (Range 86%-92%) of the individuals in these groups were New Screened Patients, meaning they had no record of these conditions during Period 1.

Figure A6 shows weekly trends and an eight-week moving average of visits from the week of 22 November 2020 through the week of 30 November 2022. CNS and GI diagnoses were tracked because these categories of diagnoses were indicated as conditions of ongoing concern in a September 2022 Agency for Toxic Substances and Disease Registry (ATSDR) survey. Toxic Effects were tracked because clinicians were advised by DOH to use those diagnostic codes at the time of the release event.

There were 166 visits for CNS symptoms in the week of 28 November 2021, immediately after the DOH advisory, which is an increase of 100% over the prior week's visits. The week of 05 December 2021, there were 205 visits for CNS diagnoses, the highest in the surveillance period. The number of visits returned to previous levels the following week. Visits for CNS symptoms did not show a statistically significant trend across the surveillance period [using the Mann Kendall Trend Test, p=0.2795].

The number of visits for GI symptoms peaked the week of 28 November 2021, returning to the previous levels the week of 19 December 2021 and showed an overall statistically significant downward trend across the remainder of Period 2 [Mann Kendall Trend Test,  $p < 0.0001$ ].

The number of visits for Toxic Effects symptoms peaked in the week of 05 December 2021 and remained elevated through March 2022 before returning to the previous levels. The overall trend for the surveillance period was not statistically significant [Mann Kendall Trend Test,  $p=0.5641$ ].

Figure A7 shows weekly trends and an eight-week moving average of visits for Respiratory, Dermatological, and Mucous Membrane diagnoses. There were 73 visits for Respiratory symptoms the week of 28 November 2021. This marks a 74% increase from the previous week, though it is not out of range for the preceding months. The Respiratory category showed statistically significant increases in the number of visits starting in July 2021 and remained elevated through the observation period [Mann Kendall Trend Test,  $p=0.0030$ ].

The number of visits for Dermatological symptoms peaked with 74 during the week of 28 November 2021 and returned to previous levels in late December. Dermatological diagnoses did not show a statistically significant trend across the surveillance period [Mann Kendall Trend Test,  $p=0.0811$ ].

There were 16 visits for Mucous Membrane symptoms the week of 05 December 2021. The number of visits returned to previous levels the following week. Mucous Membrane diagnoses did show a statistically significant increase across the period [Mann Kendall Trend Test,  $p=0.0002$ ] but remained below 20 visits per week (see Figure A7).

## Discussion

This report examined the medical visit coding data for the DoD-affiliated population, Red Hill Cohort, from 01 January 2021 to 30 November 2022. This report specifically evaluated ICD-10 codes representing symptoms known to be associated with JP-5 exposure. Medical visits for symptoms that could be related JP-5 exposure in the Red Hill Cohort population were utilized to assess possible health impacts from potential exposure since exposure level data at the water tap in each residence is not known.

There was an initial increase in the number of visits for diagnoses of interest after the Hawai'i DOH issued their 29 November 2021 advisory for residents on the Navy's JBPHH water system.<sup>1</sup> The diagnoses of interest fall under six ICD-10 diagnostic categories and four (CNS, GI, Dermatological, Mucous and Toxic Effects) showed an increase in the number of patient visits in the weeks following the 20 November 2021 release event when compared to the previous 11 months. Of those, the trend analysis showed visits for the CNS diagnostic group peaked one week

after the DOH advisory and returned to previous levels the following week with no weekly trend increases thereafter. Visits related to GI symptoms peaked the week of the DOH advisory and returned to pre-release levels in late December 2021, followed by a downward trend for the remainder of the surveillance period. Visits related to Toxic Effects peaked the week of 05 December 2021, remained elevated through March 2022, and then returned to levels prior to the event release. This is likely related to the DOH advisory directing providers to use the Toxic Effects ICD-10 codes for patients impacted by the fuel release event to standardize documentation of visits for this event. Visits for Dermatological symptoms peaked the week of 28 November 2021 but returned to prior levels in late December 2021. Visits for Mucous symptoms were slightly elevated the week of 05 December 2021 but returned to previous levels the next week. This analysis supports the statement made by the Hawai'i DOH soon after the event that based on available data "people exposed to contaminated drinking water in this incident are not expected to experience long-term health effects."<sup>1,2</sup>

Respiratory and Mucous Membrane diagnoses were the only two diagnostic categories that showed statistically significant increases across the entire observation period. This may have been driven by seasonal respiratory illnesses, as the increase in Respiratory diagnoses showed a marked increase starting in July 2021, five months prior to the release event.

Among the Red Hill Cohort, 7,473 (26.8%) had a diagnosis of interest that could be related to possible JP-5 exposure. Of this group, 820 patients (2.9%) were New Patients that had Multiple Visits for the same diagnosis. This group may require further corroboration of diagnoses to medical history with a chart review. This population surveillance report is based on electronic ICD-10-CM administrative data and cannot establish cause and effect or determine if these diagnoses are specifically related to the release event. However, it does provide information that may guide future surveillance monitoring in this population.

### Limitations

This report is limited to available diagnostic codes entered into the electronic health record based on patient reports of symptoms to a health care provider. The administrative data analyzes specific codes that may be related to JP-5 exposure on a population level; however, since potentially associated symptoms are common across many conditions, specific codes for a diagnosis of interest cannot be corroborated to either concerns of JP-5 exposure or an unrelated medical issue. Data for medical surveillance are considered provisional, and medical case counts may change if the electronic medical record is updated after this report is generated. Additionally, because purchased care records are submitted into the health care system at different times, there may be a time lag that could alter the findings and conclusions of this report. The authors made every effort to obtain the most up-to-date records available.

## Glossary

**Comprehensive Ambulatory Professional Encounter Record (CAPER):** Records created by providers after a visit with a patient using the military health system. Each observation in CAPER file represents an ambulatory visit at an MTF, inpatient rounds data, or administrative function.

**DoD Health Care Providers (HCP):** A physician, physician assistant, nurse practitioner, advanced practice nurse, independent duty corpsman, independent duty medical technician, independent health services technician, special forces medical sergeant, or dentist who works for the DoD. The term “health care provider” is broader than “licensed independent practitioner.”

**GENESIS Admissions Table:** Inpatient data from military electronic health records. Each observation in the GENESIS Admissions table represents an inpatient admission to an MTF that has transitioned to the MHS GENESIS system.

**GENESIS Episodic Encounter Table:** Records created by providers after a visit with a patient using the MHS electronic medical records system, MHS GENESIS, established in 2019. Each observation in the GENESIS Episodic Encounter table represents a visit at an MTF that has transitioned to the MHS GENESIS system and includes ambulatory or administrative function data.

**JP-5:** JP-5 fuel is a kerosene-based fuel used in military aircraft and is mostly Total Petroleum Hydrocarbons (TPH) diesel range organics.

**MHS Direct Care:** Medical care provided to Service members and beneficiaries from health care facilities and medical support organizations owned by the DoD.

**Military Health System (MHS):** A health system that supports the military mission by fostering, protecting, sustaining, and restoring health and providing the direction, resources, health care providers, and other means necessary for promoting the health of the beneficiary population.

**Multiple Visits:** Patients with multiple visits had three or more visits with the same diagnosis during Period 2.

**New Screened:** New patients that only had initial screening assessment with the same diagnosis (1 to 2 visits) in Period 2.

**New Patients:** New patients with multiple visits for care beyond their initial assessment with the same diagnosis ( $\geq 3$  visits) in Period 2 *and* 0-2 visits with the same diagnosis during Period 1.

**Pre-established Patients:** Pre-existing patients with multiple visits for care with the same diagnosis after the event ( $\geq 3$  visits) *and* three or more visits with the same diagnosis during Period 1.

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**Purchased Care:** Medical care provided by civilian providers, including individuals, groups, hospitals, and clinics, who have agreed to accept TRICARE beneficiaries. Providers in the purchased care system generally deliver health care at negotiated rates, adhere to provider agreements, and follow other requirements of the managed care program.

**Red Hill Cohort:** DoD-affiliated military housing residents (including Coast Guard) at JBPHH, temporary additional duty (TAD)/temporary duty travel (TDY) visitors, and base workers at the time of the JP-5 fuel release into its water system on 20 November 2021.

**Red Hill Cohort Period 1:** A pre-event baseline with visit data from 20 November 2020 to 19 November 2021.

**Red Hill Cohort Period 2:** After event visit data from 20 November 2021 to 30 November 2022.

**Standard Inpatient Data Record (SIDR):** Inpatient data from military electronic health records. Each observation in SIDR file represents an inpatient admission to an MTF.

**TRICARE funded HCP:** Civilian providers, including individuals, groups, hospitals, and clinics who provide health care to DoD beneficiaries and bill through the TRICARE health care program.

**TRICARE Encounter Data Non-Institutional (TED-NI):** Records created by providers after a visit with a patient using the TRICARE health care program. Each observation in TED-NI represents an ambulatory visit.

**TRICARE Encounter Data Institutional (TED-I):** Inpatient records created after an inpatient admission for a patient using the TRICARE health care program.

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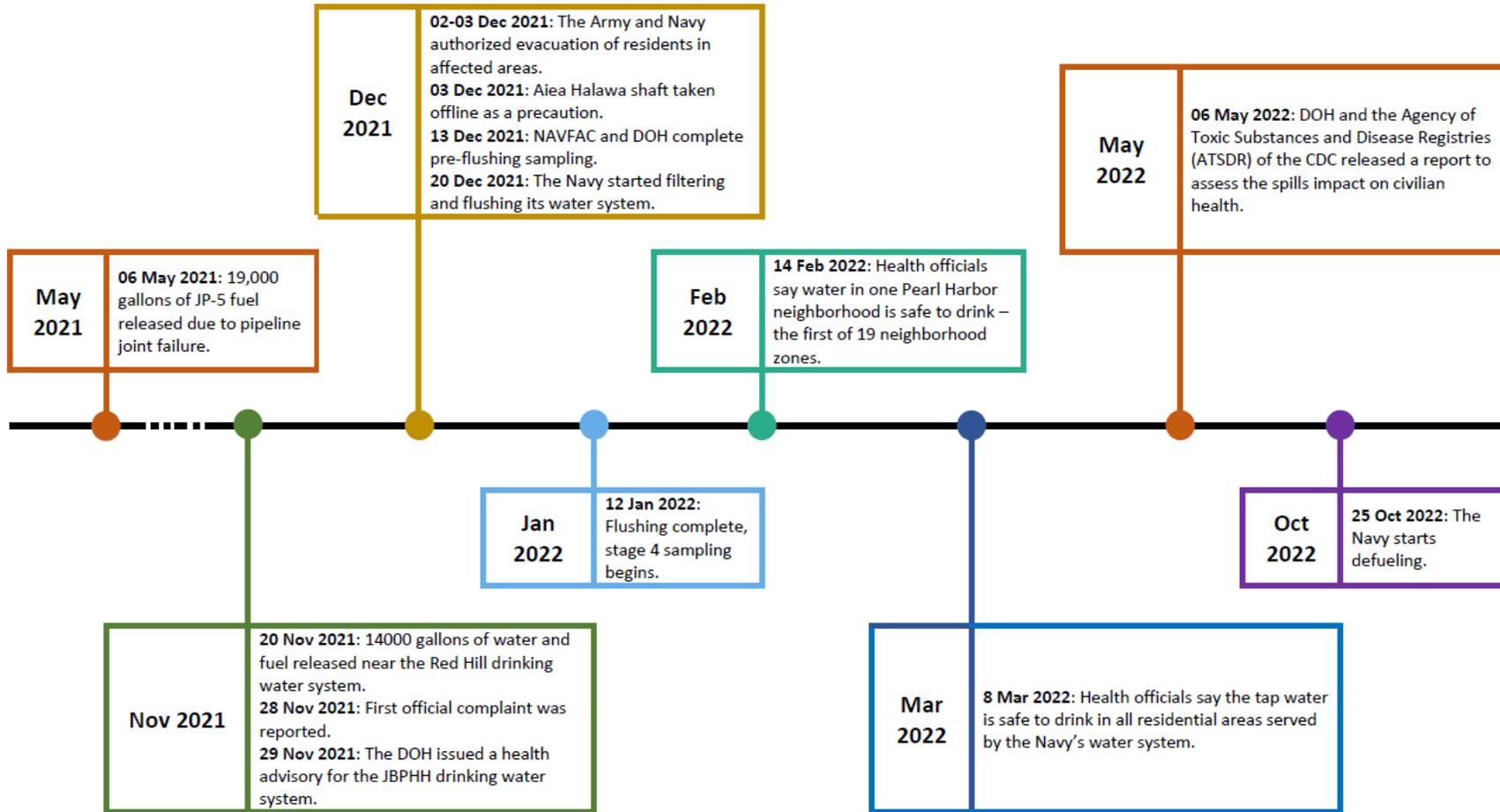
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## Appendix A

<b>Table A1. Symptoms Associated with Hydrocarbon Exposure<sup>1,2</sup></b>		
<b>Symptom</b>	<b>Description</b>	<b>ICD-10 CODE</b>
Central Nervous System	Migraine	G43*
	Headache	R51*
	Lethargy/fatigue	R53.8*
	Gait disturbances	R26.8*
	Concentration deficits	R41.8*
	Dizziness and giddiness	R42
Respiratory	Cough	R05*
	Shortness of Breath	R06.0*
	Runny Nose / rhinorrhea	R09.82
	Respiratory conditions due to inhalation of chemicals, gases, fumes and vapors	J68*
Gastrointestinal	Nausea	R11.0
	Vomiting	R11.1*
	Nausea with vomiting, unsp	R11.2
	Diarrhea	R19.7
	Generalized Abdominal pain	R10.84
	Unsp abdominal pain	R10.9
	Acute abdomen	R10.0
	Pain localized to upper abdomen	R10.1*
Pain localized to other parts of lower abdomen	R10.3*	
Dermatological	Dermatitis, unsp	L30.9
	Irritant contact dermatitis due to solvents	L24.2
	Irritant contact dermatitis due to other agents	L24.89
	Irritant contact dermatitis, unsp	L24.9
	Rash & other nonspecific skin eruption	R21
	Unsp contact dermatitis, unsp cause	L25.9
	Unsp contact dermatitis due to other agents	L25.8
Mucous Membranes	Throat pain (pharygel) pain	R07.1
	Chest Pain with breathing	R07.0
	Ocular pain	H57.1*
	Increased eye lacrimation	H04.21*
	Chemical conjunctivitis	H10.21
Toxic Effects	Contact with and (suspected) exposure to environmental pollution	Z77.11
	Toxic effect of organic solvents	T52*
	Toxic effect of halogen derivatives of aliphatic & aromatic hydrocarbons	T53*
	Toxic effect of other gases, fumes and vapors	T59*
	Toxic effect of other & unsp substances	T65*

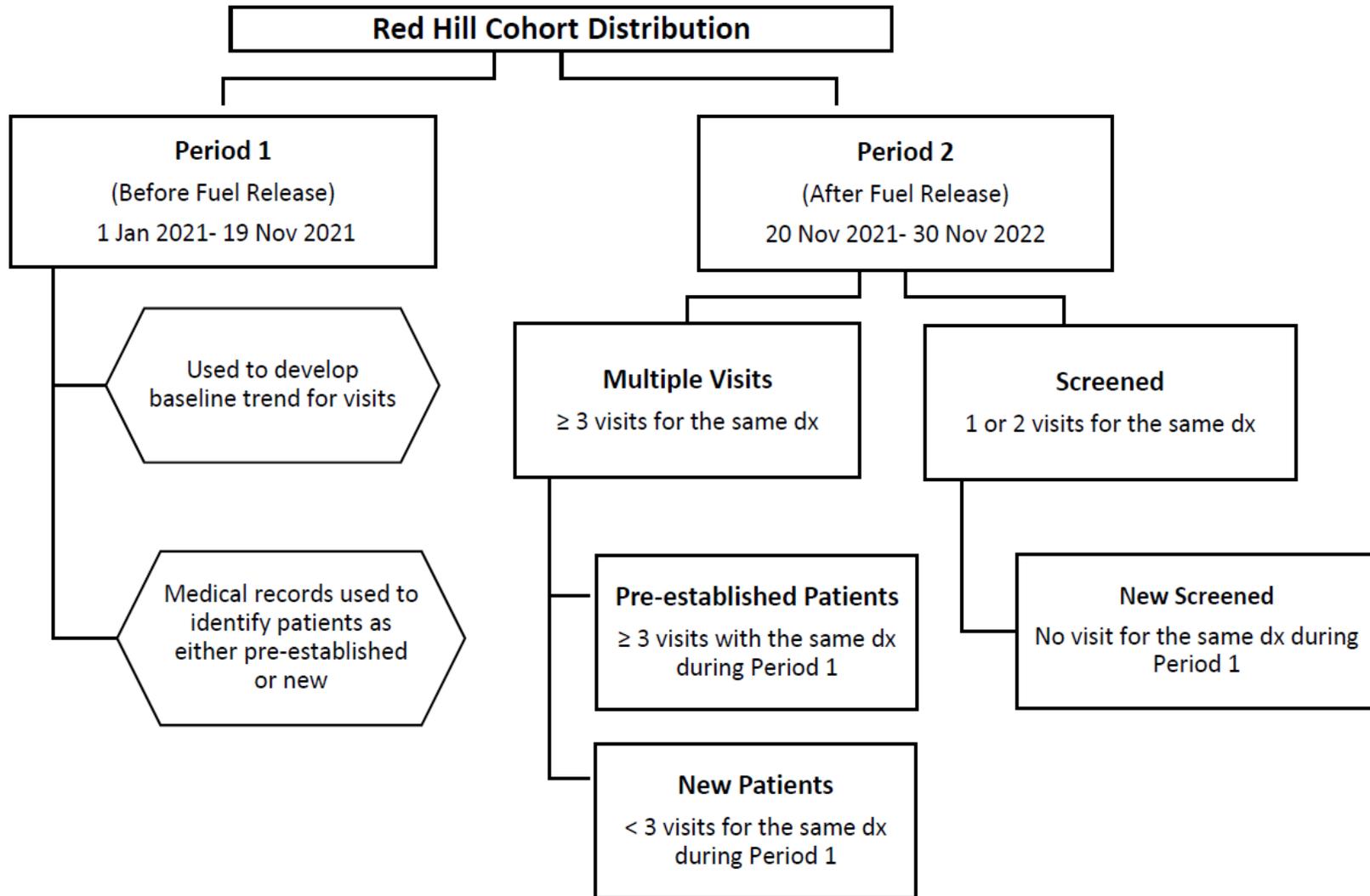
Red Hill Medical Review  
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Figure A1. Red Hill Timeline of Key Events<sup>3,5,12,13</sup>



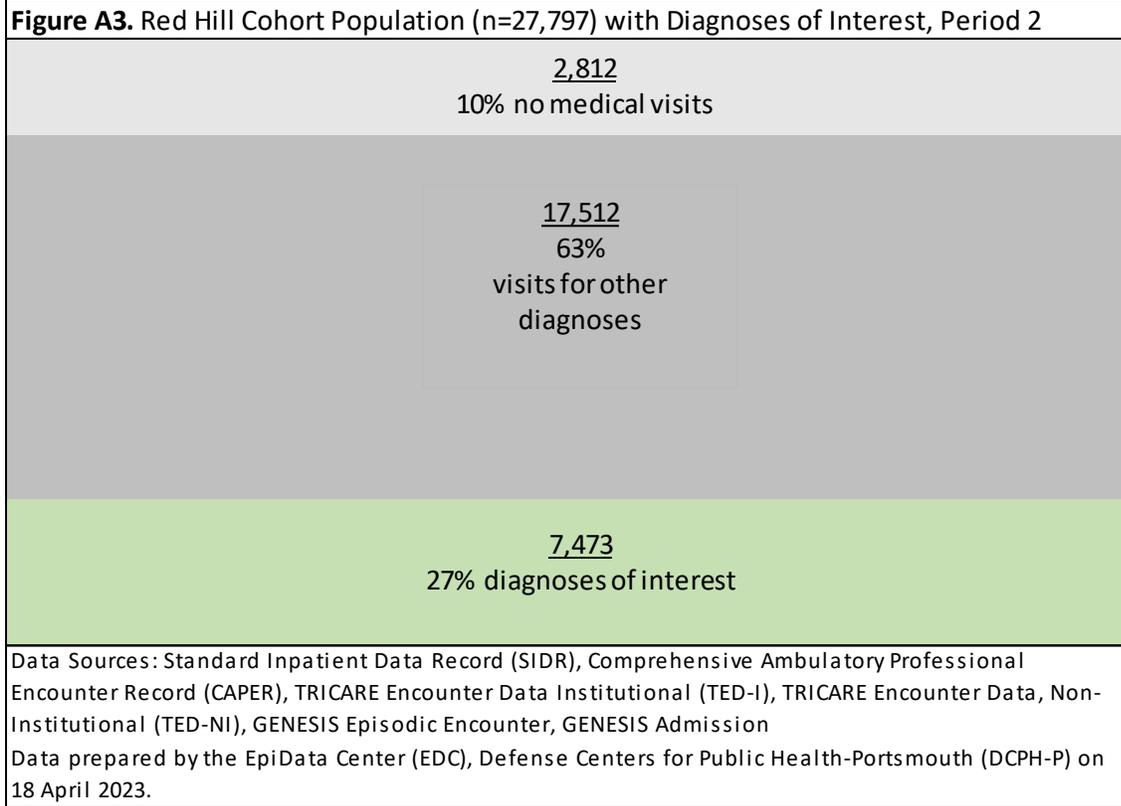
Prepared by the EpiData Center (EDC), Defense Centers for Public Health-Portsmouth (DCPH-P) on 18 April 2023.

Figure A2. Overview of the Distribution of the Red Hill Cohort for Medical Visits

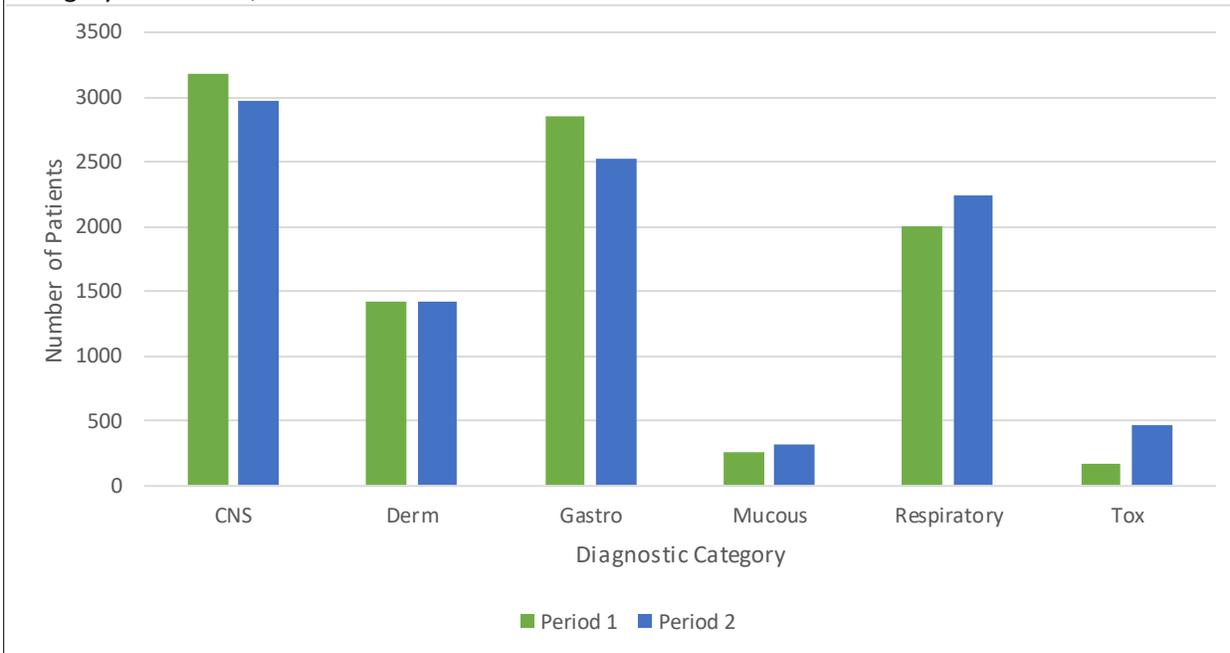


Prepared by the EpiData Center (EDC) Defense Centers for Public Health-Portsmouth (DCPH-P) on 27 April 2023.

<b>Table A2. Demographics of Red Hill Cohort</b>		
<b>Sex</b>	<b>No.</b>	<b>Percent</b>
Female	12,697	45.68
Male	15,100	54.32
<b>Beneficiary Category</b>		
Active Duty Family	14,351	51.63
Active Duty	10,458	37.62
Retiree Family	1,112	4.00
Retirees	673	2.42
Dep of Guard/Res on AD	640	2.30
Guard/Res on AD	319	1.15
Inactive Guard/Res Family	93	0.33
Inactive Guard/Res	77	0.28
Other	66	0.24
Survivor	8	0.03
<b>Service</b>		
Navy	11,579	41.66
Army	7,510	27.02
Air Force	7,240	26.05
Coast Guard	705	2.54
Marine Corps	609	2.19
Space Force	141	0.51
Public Health Service	10	0.04
National Oceanic & Atmospheric Admin	2	0.01
Foreign Army	1	0.00
<b>Age Group</b>		
0-4	2,009	7.23
5-14	5,846	21.03
15-17	1,148	4.13
18-24	4,622	16.63
25-34	6,288	22.62
35-44	5,527	19.88
45-64	2,224	8.00
65+	133	0.48
<b>Race Ethnic Code</b>		
Unknown	7,377	26.54
White, not Hispanic	7,037	25.32
Missing Data	6,768	24.35
Black, not Hispanic	2,181	7.85
Hispanic	2,065	7.43
Asian or Pacific Islander	1,401	5.04
Other	749	2.69
American Indian/Alaskan Native	219	0.79
Data Source: Military Health System Management and Analysis Reporting Tool (M2)		
Data prepared by the EpiData Center (EDC), Defense Centers for Public Health-Portsmouth (DCPH-P) on 18 April 2023.		



**Figure A4.** Annualized Number of Patients with at least one Diagnosis of Interest by Diagnostic Category and Period, Red Hill Cohort



Data Sources: Standard Inpatient Data Record (SIDR), Comprehensive Ambulatory Professional Encounter Record (CAPER), TRICARE Encounter Data Institutional (TED-I), TRICARE Encounter Data, Non-Institutional (TED-NI), GENESIS Episodic Encounter, GENESIS Admission

Numbers are annualized, to correct for the fact that Period 1 and Period 2 are not of equal length.

\*Patients may be included in more than one diagnostic category.

Data prepared by the EpiData Center (EDC), Defense Centers for Public Health-Portsmouth (DCPH-P) on 26 April 2023.

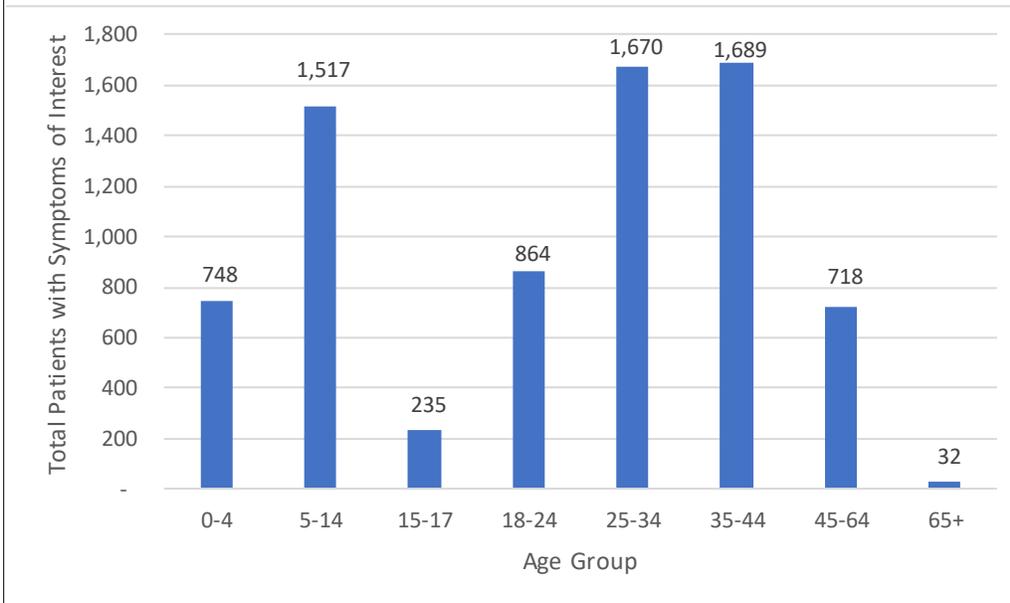
Red Hill Medical Review  
Prepared August 2023

**Table A3. Number of Patients with Symptoms Consistent with JP-5 Fuel Exposure by Diagnostic Category and Age Group, Red Hill Cohort, Period 2**

Diagnostic Category	Diagnosis Description	Age Groups								Diagnostic Total*
		0 to 4	5 to 14	15 to 17	18 to 24	25 to 34	35 to 44	45 to 64	65+	
Central Nervous System	Concentration	7	109	15	49	76	61	38	2	357
	Dizziness & giddiness	0	36	19	58	130	122	80	4	449
	Lethargy/fatigue	20	64	26	64	220	268	99	5	766
	Gait disturbances	13	38	14	15	16	31	24	3	154
	Headache	13	196	44	160	368	329	116	0	1,226
	Migraine	2	35	15	75	240	350	137	2	856
Dermatological	Irritant contact dermatitis due to other agents	1	3	1	1	1	0	0	0	7
	Rash and other non-specific skin eruption	152	199	22	62	163	155	79	0	832
	Irritant contact dermatitis due to solvents	0	0	0	0	0	0	0	0	0
	Unspecified contact dermatitis, unspecified cause	9	17	2	13	27	30	15	0	113
	Dermatitis, unspecified	86	136	21	49	122	144	65	5	628
	Irritant contact dermatitis, unspecified cause	4	1	0	1	7	8	1	1	23
Gastrointestinal	Unspecified contact dermatitis due to other agents	1	1	0	0	3	1	0	0	6
	Acute Abdominal Pain	2	1	0	2	7	1	2	0	15
	Diarrhea	105	93	18	64	168	141	38	3	630
	Generalized abdominal pain	17	50	12	25	39	25	19	2	189
	Pain localized to other parts of the lower abdomen	8	63	14	54	107	103	49	0	398
	Nausea	4	62	17	58	141	76	26	0	384
	Nausea and Vomiting	44	70	16	77	113	54	17	1	392
	Unspecified abdominal pain	42	215	30	156	244	246	97	4	1,034
	Pain localized to the upper abdomen	4	41	10	39	95	107	39	1	336
Mucous Membranes	Vomiting	151	160	6	57	70	28	7	1	480
	Chest pain with breathing	6	68	11	34	64	40	13	0	236
	Chemical conjunctivitis	0	3	0	2	0	0	0	0	5
	Increased eye lacrimation	0	0	0	0	0	0	0	0	0
	Ocular pain	2	6	2	13	24	18	11	0	76
Respiratory	Throat pain	0	1	4	1	2	8	2	0	18
	Cough	414	511	47	168	330	296	119	9	1,894
	Respiratory conditions due to inhalation of chemical, gases, fumes and vapors	0	0	0	0	2	2	0	0	4
	Rhinorrhea	6	17	3	8	18	29	10	0	91
Toxic Effects	Shortness of breath	24	61	9	69	128	133	83	6	513
	Toxic effect of halogen derivatives of aliphatic & aromatic hydrocarbons	0	2	0	0	0	2	0	0	4
	Contact with and suspected exposure to environmental pollution	47	123	16	23	69	104	47	0	429
	Toxic effect of other gases, fumes and vapors	5	3	0	1	6	3	1	0	19
	Toxic effect of other and unspecified substances	3	3	0	1	4	5	1	0	17
	Toxic effect of organic solvents	0	4	2	3	5	6	6	0	26

Data Sources: Standard Inpatient Data Record (SIDR), Comprehensive Ambulatory Professional Encounter Record (CAPER), TRICARE Encounter Data Institutional (TED-I), TRICARE Encounter Data, Non-Institutional (TED-NI), GENESIS Episodic Encounter, GENESIS Admission.  
\*Patients may have more than one diagnosis.  
Prepared by the EpiData Center (EDC), Defense Centers for Public Health-Portsmouth (DCPH-P) on 18 April 2023.

**Figure A5.** Total Patients with Symptoms Consistent with JP-5 Fuel Exposure by Age Group, Period 2



Data Sources: Standard Inpatient Data Record (SIDR), Comprehensive Ambulatory Professional Encounter Record (CAPER), TRICARE Encounter Data Institutional (TED-I), TRICARE Encounter Data, Non-Institutional (TED-NI), GENESIS Episodic Encounter, GENESIS Admission Data prepared by the EpiData Center (EDC), Defense Centers for Public Health-Portsmouth (DCPH-P) on 18 April 2023.

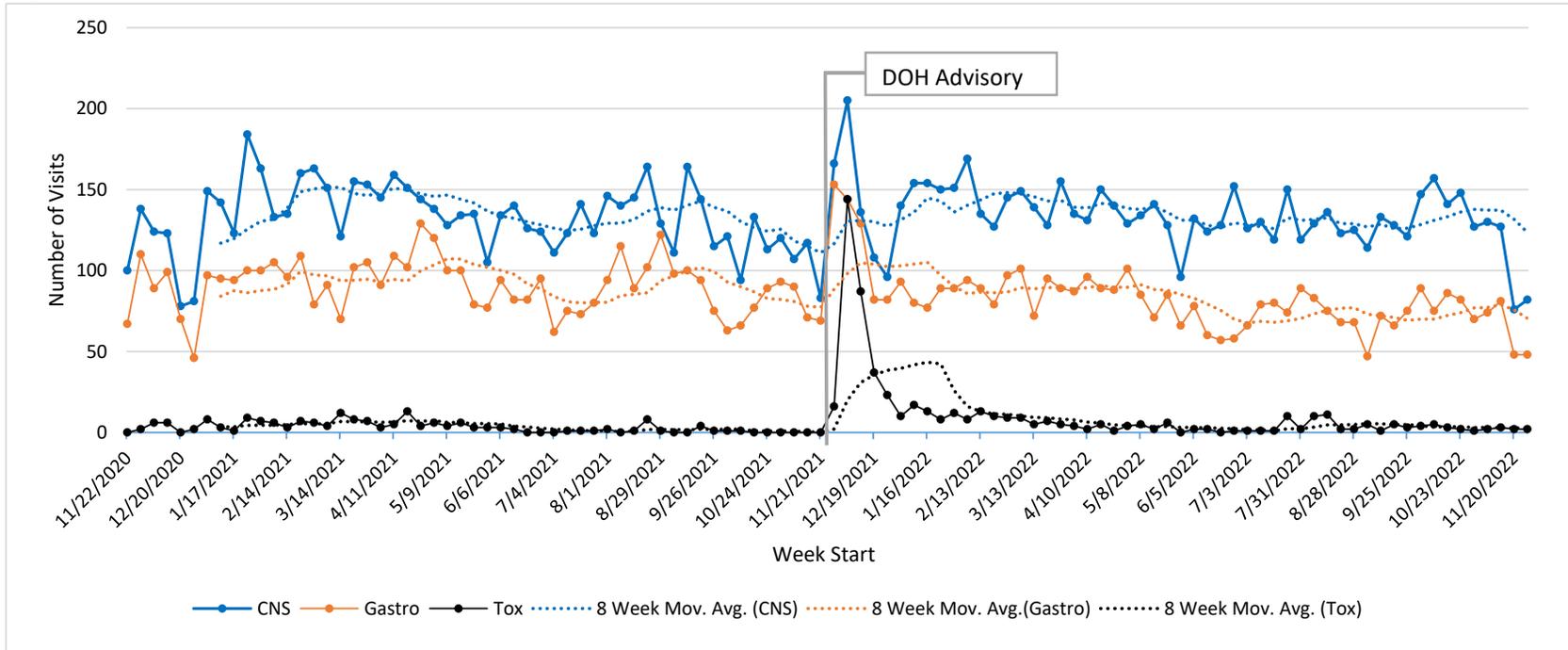
Red Hill Medical Review  
Prepared August 2023

**Table A4.** Patients with Multiple Visits vs. Screened Patients by ICD-10 Code Consistent with JP-5 Exposure, Red Hill Cohort, Period 2

Diagnosis Category	Diagnosis Description	ICD-10	Patients with Multiple Visits								Screened Patients	
			New Patients				Pre-established Patients				Total N	No. New Screened
			Total N	No. New Patients	Median No. Visits	Range of Visits	No. Pre-established Patients	Median No. Visits	Range of Visits			
Central Nervous System	Concentration	R41.8	65	56	4	3-43	9	34	3-47	292	273	
	Dizziness & giddiness	R42	77	68	4	3-12	9	4	3-27	372	334	
	Lethargy/fatigue	R53.8	71	61	3	3-20	10	6	3-17	695	609	
	Gait disturbances	R26.8	87	75	7	3-48	12	11	4-35	67	62	
	Headache	R51	90	83	3	3-20	7	6	4-11	1,136	973	
	Migraine	G43	271	152	4	3-18	119	5	3-32	585	416	
Dermatological	Irritant contact dermatitis due to other agents	L24.89	1	1	8	8-8	0	-	-	6	6	
	Rash and other non-specific skin eruption	R21	26	25	3	3-19	1	7	7-7	806	740	
	Unspecified contact dermatitis, unspecified cause	L25.9	2	2	4	3-4	0	-	-	111	108	
	Dermatitis, unspecified	L30.9	46	41	3	3-8	5	5	4-17	582	512	
	Irritant contact dermatitis, unspecified cause	L24.9	0	0	-	-	0	-	-	23	22	
	Unspecified contact dermatitis due to other agents	L25.8	0	0	-	-	0	-	-	6	6	
Gastrointestinal	Acute Abdominal Pain	R10.0	0	0	-	-	0	-	-	15	15	
	Diarrhea	R19.7	69	65	3	3-11	4	5	4-13	561	514	
	Generalized abdominal pain	R10.84	13	13	4	3-12	0	-	-	176	165	
	Pain localized to other parts of the lower abdomen	R10.3	45	43	3	3-14	2	14	6-22	353	326	
	Nausea	R11.0	24	22	3	3-7	2	7	5-9	360	331	
	Nausea and Vomiting	R11.2	28	24	3	3-40	4	8	3-12	364	333	
	Unspecified abdominal pain	R10.9	116	103	3	3-12	13	4	3-19	918	819	
	Pain localized to the upper abdomen	R10.1	52	45	4	3-12	7	4	3-5	284	249	
	Vomiting	R11.1	33	32	4	3-10	1	17	17-17	447	422	
Mucous Membranes	Chest pain with breathing	R07.0	8	8	3	3-9	0	-	-	228	228	
	Chemical conjunctivitis	H10.21	0	0	-	-	0	-	-	5	5	
	Increased eye lacrimation	H04.21	0	0	-	-	0	-	-	0	0	
	Ocular pain	H57.1	5	5	3	3-3	0	-	-	71	70	
	Throat pain	R07.1	0	0	-	-	0	-	-	18	17	
Respiratory	Cough	R05	178	163	3	3-15	15	4	3-9	1,716	1,479	
	Respiratory conditions due to inhalation of chemical, gases, fumes and vapors	J68	0	0	-	-	0	-	-	4	4	
	Rhinorrhea	R09.82	2	2	5	4-5	0	-	-	89	89	
	Shortness of breath	R06.0	87	79	3	3-10	8	4	3-6	426	380	
	Toxic Effects	Toxic effect of halogen derivatives of aliphatic & aromatic hydrocarbons	T53	1	1	3	3-3	0	-	-	3	3
Contact with and suspected exposure to environmental pollution		Z77.11	7	7	4	3-5	0	-	-	422	419	
Toxic effect of other gases, fumes and vapors		T59	0	0	-	-	0	-	-	19	19	
Toxic effect of other and unspecified substances		T65	0	0	-	-	0	-	-	17	17	
Toxic effect of organic solvents		T52	5	5	4	3-12	0	-	-	21	21	

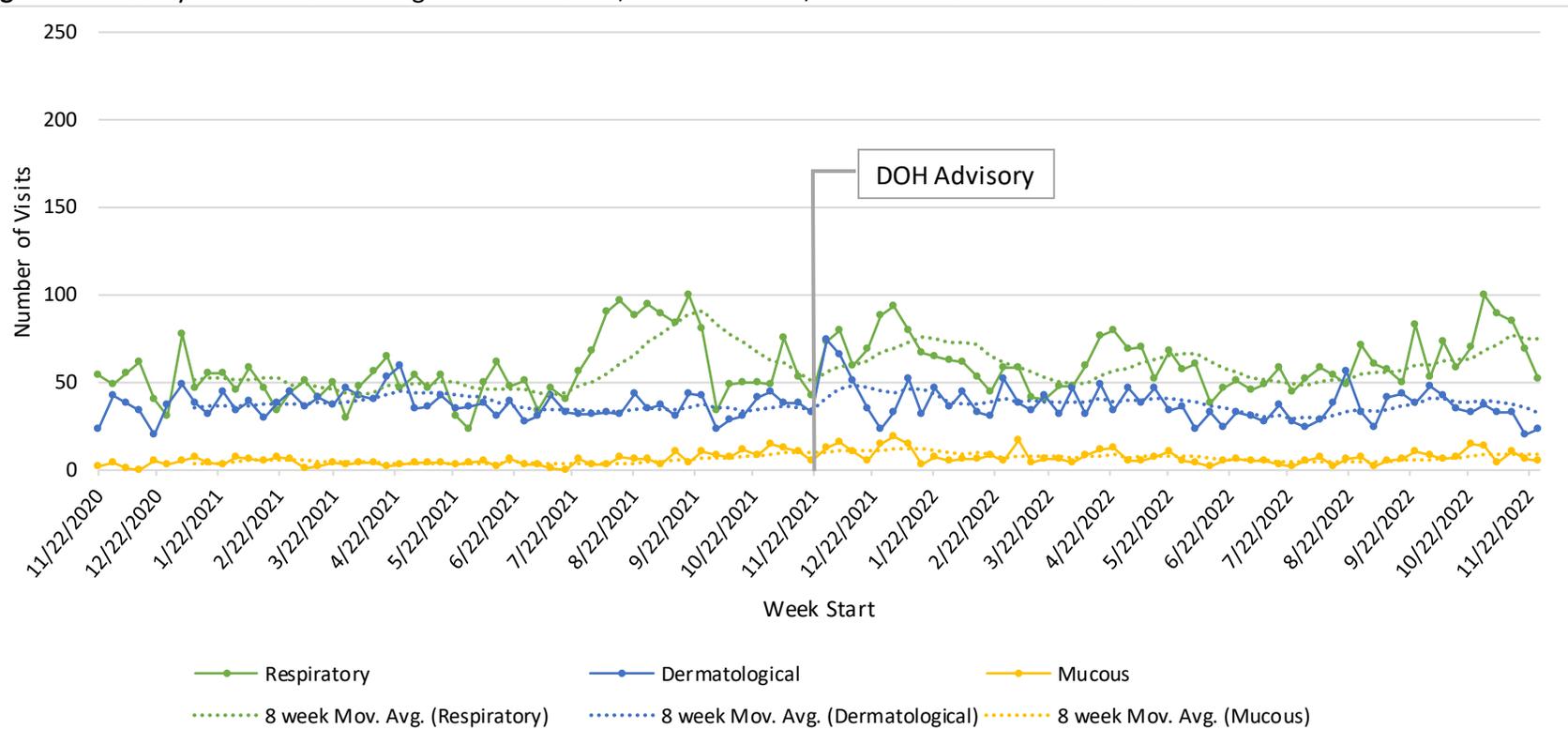
Data Sources: Standard Inpatient Data Record (SIDR), Comprehensive Ambulatory Professional Encounter Record (CAPER), TRICARE Encounter Data Institutional (TED-I), TRICARE Encounter Data, Non-Institutional (TED-NI), GENESIS Episodic Encounter, GENESIS Admission  
 \*Patients may be included in more than one diagnostic category.  
 - Represents unable to calculate.  
 Data prepared by the EpiData Center (EDC), Defense Centers for Public Health-Portsmouth (DCPH-P) on 18 April 2023.

**Figure A6.** Number of Visits for Selected Potential JP-5 Exposure Conditions by Week, Red Hill Cohort, 22 November 2020 - 30 November 2022



Data Sources: Standard Inpatient Data Record (SIDR), Comprehensive Ambulatory Professional Encounter Record (CAPER), TRICARE Encounter Data Institutional (TED-I), TRICARE Encounter Data, Non-Institutional (TED-NI), GENESIS Episodic Encounter, GENESIS Admission  
Data prepared by the EpiData Center (EDC), Defense Centers for Public Health-Portsmouth (DCPH-P) on 09 August 2023.

Figure A7. Weekly Visits for Other Diagnoses of Interest, Red Hill Cohort, 22 November 2020 - 30 November 2022



Data Sources: Standard Inpatient Data Record (SIDR), Comprehensive Ambulatory Professional Encounter Record (CAPER), TRICARE Encounter Data Institutional (TED-I), TRICARE Encounter Data, Non-Institutional (TED-NI), GENESIS Episodic Encounter, GENESIS Admission  
Data prepared by the EpiData Center (EDC), Defense Centers of Public Health-Portsmouth (DCPH-P) on 09 August 2023.