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Medical Surveillance Monthly Report

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Data in the MSMR is provisional, based on reports and other sources of data available to the Medical Surveillance Activity. Notifiable conditions are reported by date of onset (or date of notification when date of onset is absent). Only cases submitted as confirmed are included.

Case Reports

Hyponatremia associated with heat stress and excessive water consumption: Fort Benning, GA; Fort Leonard Wood, MO; Fort Jackson, SC June – August 1997

On 16 July 1997, the preventive medicine activity at Fort Benning, Georgia, notified the Army Medical Surveillance Activity (AMSA) of four cases of "hyposmolality" among basic infantry trainees — one case was fatal and another required intensive medical care. In response, the AMSA contacted other basic training posts to alert them to the cases at Fort Benning and to assess the experience at other installations. This survey revealed three recent cases of severe hyponatremia at Fort Jackson, South Carolina, and a fourth case at Fort Leonard Wood, Missouri. The following reports illustrate factors associated with and clinical manifestations of hyponatremia secondary to excessive water consumption.

Case #1, Fort Benning, Georgia: On 2 July 1997, an 18 year-old native American soldier from Alaska was admitted to the hospital with the acute onset of rapidly progressing weakness that led to unresponsiveness. He was in his fourth week of basic infantry training when, on the evening prior to hospitalization, he complained of headache and nausea. On the morning of admission, he moved with his unit to the rifle range. As the day progressed, the heat category rose to level 5 (wet bulb globe temperature (WBGT) > 90^{o}), and by mid-morning, he complained of light-headedness and nausea and he vomited. Since the weather and his symptoms suggested heat stress, he was moved to the shade, his clothing was loosened, and he was given water. Over the next 1.5 hours, he drank approximately four quarts of water, and his symptoms seemed to resolve. By mid-day, he again complained of headache, nausea, dizziness, and feeling overheated. He vomited again and required assistance walking. He was placed in the shade and instructed to drink more water. Over the next two hours, he drank an estimated 10-14 canteens of water and vomited repeatedly.

By mid-afternoon, he was physically incapacitated and markedly obtunded. He was transported to the hospital and received approximately 0.5 liters of lactated Ringer's (LR) solution enroute. He presented to the emergency room in respiratory arrest with a Glasgow coma scale of 3. His blood pressure was 180/90 but soon dropped to 80/50. His heart rate was 150-170 and rectal temperature 98.8^{o}. Endotracheal intubation was achieved with difficulty due to frothy sputum. A neurological examination revealed fixed and dilated pupils. Upon further investigation, the soldier's medical and family histories were noted to be negative. He was taking no medications and did not drink alcohol or smoke.

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Initial laboratory assessment revealed serum sodium of 121, potassium of 3.0, magnesium of 1.4, and glucose of 206. Liver enzymes were elevated, but none were more than twice normal. Urine drug and blood alcohol screens were negative. Initial ABGs were pH of 7.05, pO2 of 36.7 and a pCO2 of 72.7. An electrocardiogram documented sinus tachycardia, and a chest radiograph revealed diffuse pulmonary edema. A CT scan revealed dilated lateral and third cerebral ventricles and edematous changes in the pons, with obliteration of the pons cistern.

Despite intensive medical care, the soldier did not regain consciousness. A cerebral flow study with contrast showed no blood flow, and an EEG showed no activity. The soldier developed sepsis and DIC, and on the fifth hospital day, he had a terminal cardiac arrest. A post-mortem examination documented severe cerebral and brainstem edema and hydrocephalus.

Case #2, Fort Leonard Wood, Missouri: On 14 July 1997, a 22-year old cadet from the US Military Academy, West Point, New York, was training as a student in the Sapper Leader Course, Fort Leonard Wood, Missouri. On the day of hospitalization, he consumed large quantities of water to prevent heat symptoms, but as the day progressed, he developed light-headedness and weakness. He presented to the troop medical clinic and was transported from there to the hospital. When he arrived at the emergency room, he was alert and oriented, but shortly thereafter, he had a generalized seizure.

His physical examination revealed blood pressure: 119/40, pulse: 73, respirations: 24 and rectal temperature: 97. His lungs were clear. He was obtunded and poorly cooperative, but he moved all extremities and responded to painful stimuli. Deep tendon reflexes were 2+ bilaterally, and Babinski's sign was absent. He did not take medications or

Continued on page 8

Figure 1. Hyponatremia hospitalizations, active duty Army, by month, 1989-1996

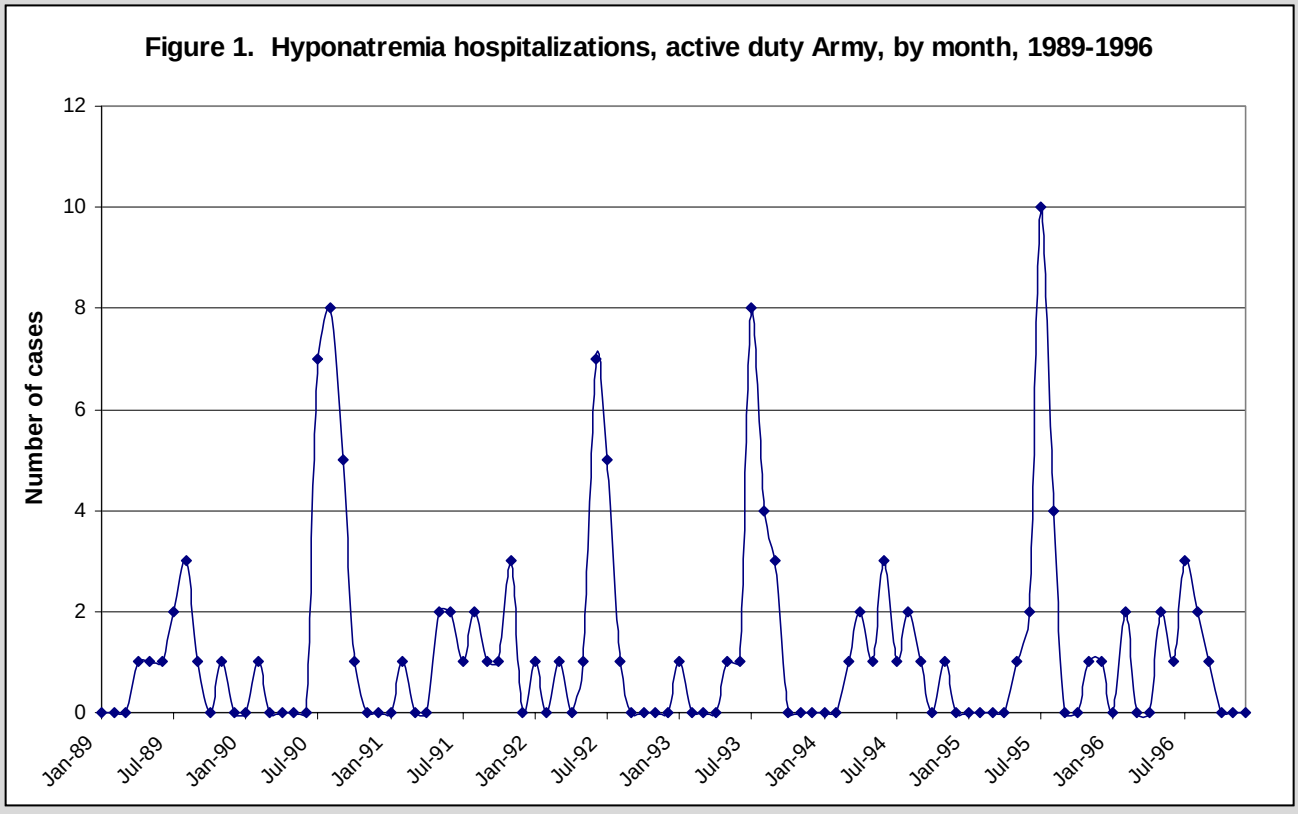


TABLE I. Selected sentinel reportable diseases, US Army medical treatment facilities* August, 1997

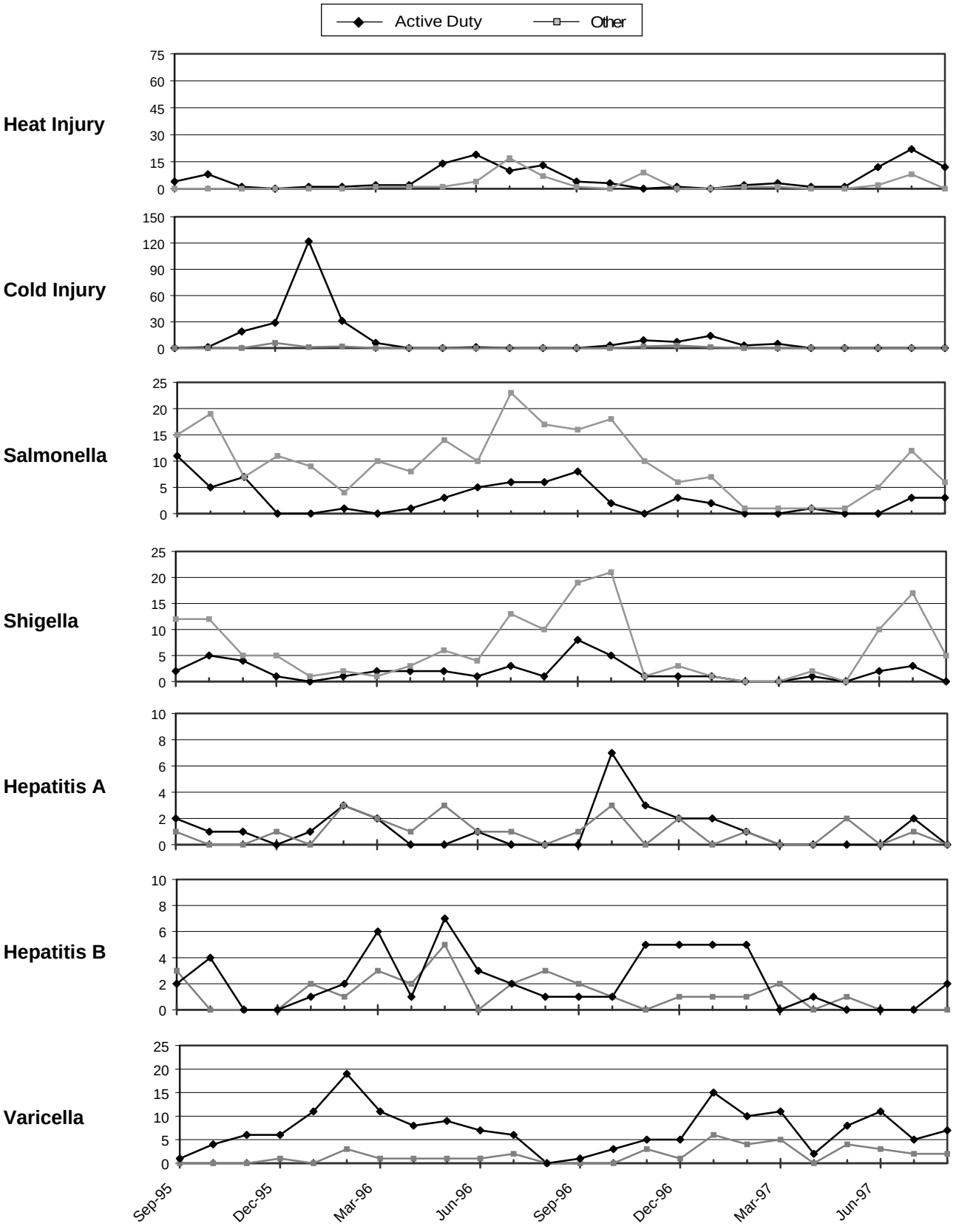
Reporting MTF/Post**	Total number of reports submitted August 1997	Environmental Injuries		Viral Hepatitis		Salmonellosis		Shigella		Varicella	
		Active Duty				Active Duty	Other	Active Duty	Other	Active Duty	Other Adult
		Heat	Cold	A	B						
		Cum. 1997	Cum. 1997	Cum. 1997	Cum. 1997	Cum. 1997	Cum. 1997	Cum. 1997	Cum. 1997	Cum. 1997	Cum. 1997
NORTH ATLANTIC RMC											
Walter Reed AMC	0	0	0	0	1	1	2	0	1	2	3
Aberdeen Prov. Ground, MD	10	1	0	0	0	0	0	0	0	0	0
FT Belvoir, VA	0	0	0	0	1	0	0	0	0	0	0
FT Bragg, NC	5	4	8	0	0	1	16	6	54	0	0
FT Drum, NY	0	0	1	0	0	0	0	0	0	4	0
FT Eustis, VA	32	9	0	1	1	0	5	0	7	4	0
FT Knox, KY	31	7	0	0	0	0	0	0	0	0	0
FT Lee, VA	10	0	0	0	0	0	0	0	0	0	0
FT Meade, MD	0	0	0	0	0	0	1	0	0	0	0
West Point, NY	0	0	0	0	1	0	1	0	0	1	0
GREAT PLAINS RMC											
Brooke AMC	59	2	0	3	0	2	3	0	4	0	0
FT Carson, CO	57	1	0	1	1	0	1	0	0	0	0
FT Hood, TX	193	2	0	2	2	0	2	0	0	3	0
FT Leavenworth, KS	6	0	0	0	1	1	0	0	0	0	0
FT Leonard Wood, MO	21	2	2	2	0	0	0	0	0	14	7
FT Polk, LA	4	5	1	0	0	0	0	0	0	0	0
FT Riley, KS	41	5	0	0	0	0	1	0	0	0	0
FT Sill, OK	92	12	0	2	3	0	0	0	0	0	0
SOUTHEAST RMC											
Eisenhower AMC	0	0	0	0	1	0	0	0	0	0	0
FT Benning, GA	38	18	0	0	0	1	0	0	0	12	2
FT Campbell, KY	67	0	13	0	0	1	2	2	0	11	6
FT Jackson, SC	47	0	0	0	1	1	1	0	0	12	0
FT McClellan, AL	0	0	0	0	0	0	0	0	0	0	0
FT Rucker, AL	7	0	0	0	0	0	0	0	0	0	0
FT Stewart, GA	82	1	0	0	0	0	1	0	0	1	0
SOUTHWEST RMC											
Wm Beaumont AMC	46	0	0	1	1	0	2	0	0	11	3
FT Huachuca, AZ	13	0	0	0	0	0	0	0	1	1	0
FT Irwin, CA	4	0	0	0	0	0	0	0	0	0	0
NORTHWEST RMC											
Madigan AMC	37	0	0	2	0	1	4	0	0	0	0
FT Wainwright, AK	0	0	0	0	0	0	0	0	0	0	0
PACIFIC RMC											
Tripler AMC	40	0	0	0	1	0	1	0	0	0	0
OTHER LOCATIONS											
Europe	63	1	1	2	15	9	18	0	5	23	0
Korea	42	5	0	0	8	1	0	1	0	4	0
Total	**1047**	**75**	**26**	**16**	**38**	**19**	**61**	**9**	**72**	**103**	**21**

* Based on date of onset.

** Reports are included from main and satellite clinics. Not all sites reporting.

Date of Report: 7-Sep-97

FIGURE I. Selected sentinel reportable diseases, US Army medical treatment facilities*
Cases per month, Sep 95 - Aug 97



* Reports are included from main and satellite clinics. Not all sites reporting.

Date of report: 7-Sep-97

TABLE II. Reportable sexually transmitted diseases, US Army medical treatment facilities*
August, 1997

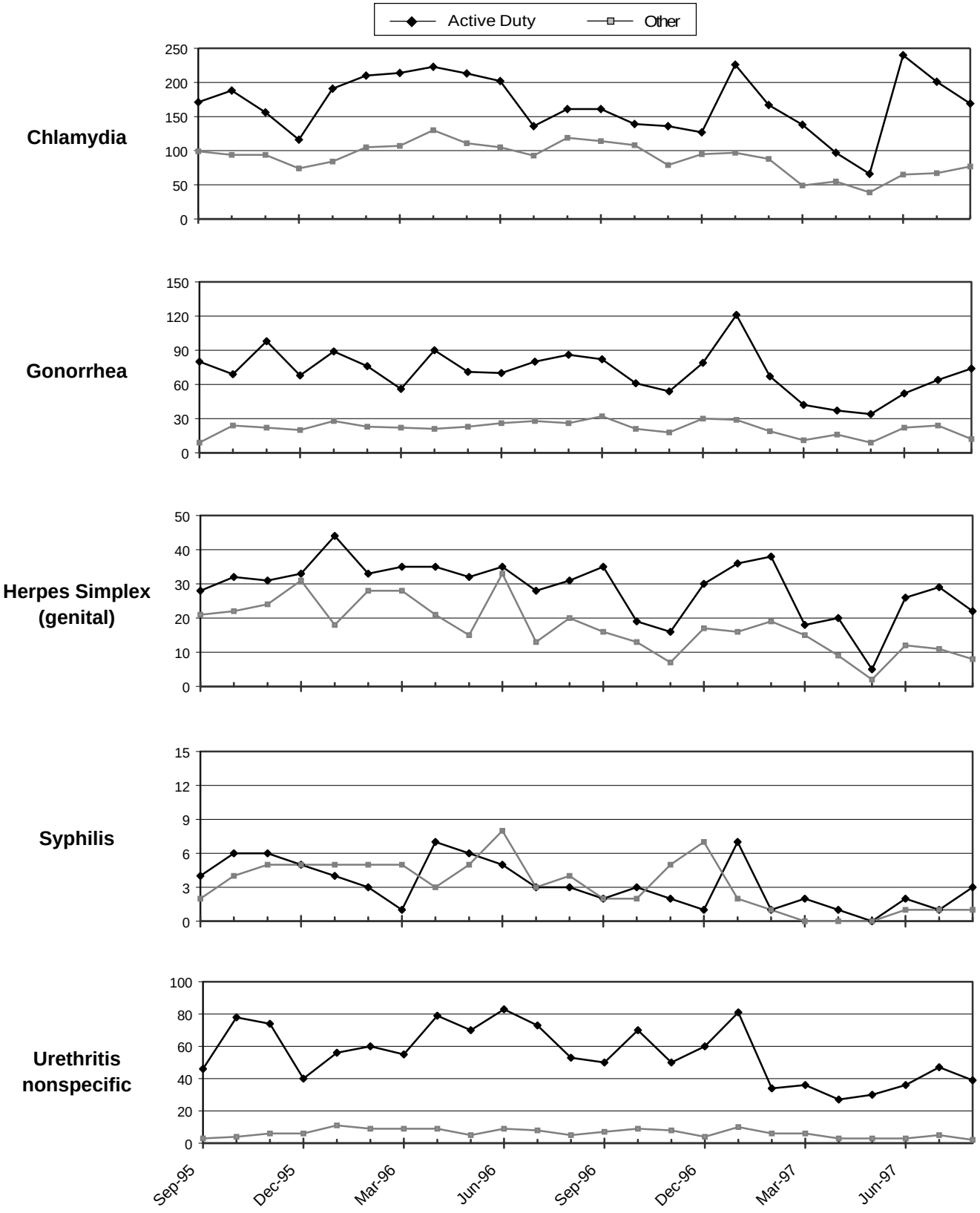
Reporting MTF/Post**	Chlamydia		Urethritis non-spec.		Gonorrhea		Herpes Simplex		Syphilis Prim/Sec		Syphilis Latent		Other STDs**	
	Cur. Month	Cum. 1997	Cur. Month	Cum. 1997	Cur. Month	Cum. 1997	Cur. Month	Cum. 1997	Cur. Month	Cum. 1997	Cur. Month	Cum. 1997	Cur. Month	Cum. 1997
NORTH ATLANTIC RMC														
Walter Reed AMC	0	35	0	6	0	15	0	13	0	1	0	0	0	0
Aberdeen Prov. Ground, MD	0	14	0	1	0	18	0	5	0	0	0	0	0	0
FT Belvoir, VA	0	2	0	0	0	0	0	0	0	0	0	0	0	0
FT Bragg, NC	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FT Drum, NY	0	15	0	4	0	9	0	1	0	0	0	0	0	0
FT Eustis, VA	13	88	0	0	5	16	0	0	0	0	1	1	0	0
FT Knox, KY	9	75	0	0	5	36	2	29	0	0	2	2	0	0
FT Lee, VA	6	18	0	0	0	2	0	0	0	0	0	0	0	0
FT Meade, MD	0	6	0	3	0	1	0	2	0	0	0	0	0	0
West Point, NY	0	0	0	0	0	0	0	0	0	0	0	0	0	0
GREAT PLAINS RMC														
Brooke AMC	6	87	0	0	2	32	0	6	0	0	0	0	0	0
FT Carson, CO	19	181	5	154	7	54	5	31	0	0	0	1	0	0
FT Hood, TX	39	336	14	135	25	196	1	39	0	2	0	0	0	5
FT Leavenworth, KS	3	20	0	0	0	5	0	0	0	0	0	0	0	0
FT Leonard Wood, MO	9	62	2	14	3	22	0	0	0	0	0	1	0	0
FT Polk, LA	0	39	0	0	0	11	0	3	0	0	0	2	0	3
FT Riley, KS	26	124	0	0	4	26	0	0	0	0	0	1	0	1
FT Sill, OK	10	119	2	29	4	48	0	9	0	0	0	0	1	4
SOUTHEAST RMC														
Eisenhower AMC	0	55	0	0	0	14	0	31	0	0	0	0	0	7
FT Benning, GA	0	36	0	0	0	48	1	24	0	0	0	2	0	0
FT Campbell, KY	16	184	0	0	19	118	3	21	0	0	0	1	0	1
FT Jackson, SC	20	539§	0	0	1	15	2	37	0	1	0	0	0	2
FT McClellan, AL	0	1	0	0	0	0	0	0	0	0	0	0	0	0
FT Rucker, AL	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FT Stewart, GA	11	81	10	112	4	80	7	46	0	0	0	2	0	27
SOUTHWEST RMC														
Wm Beaumont AMC	17	200	0	0	6	28	3	33	0	2	0	1	0	2
FT Huachuca, AZ	0	27	0	0	0	2	0	2	0	0	0	0	0	0
FT Irwin, CA	1	24	0	0	0	6	0	4	0	1	0	0	0	0
NORTHWEST RMC														
Madigan AMC	14	169	8	67	2	48	1	34	0	0	0	0	0	0
FT Wainwright, AK	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PACIFIC RMC														
Tripler AMC	20	87	0	0	7	34	4	50	0	0	0	0	0	0
OTHER LOCATIONS														
Europe	7	364	0	10	1	98	1	21	0	3	0	0	0	1
Korea	0	13	0	0	0	1	0	0	0	0	0	0	0	0
Total	**246**	**3001**	**41**	**535**	**95**	**983**	**30**	**441**	**0**	**10**	**3**	**14**	**1**	**53**

* Reports are included from main and satellite clinics. Not all sites reporting. Date of Report: 7-Sep-97

** Other STDs: (a) Chancroid (b) Granuloma Inguinale (c) Lymphogranuloma Venereum (d) Syphilis unspec. (e) Syph, tertiary (f) Syph, congenital

§ Includes participants in a large-scale ongoing chlamydia study.

FIGURE II. Reportable sexually transmitted diseases, US Army medical treatment facilities*
Cases per month, Sep 95 - Aug 97



* Reports are included from main and satellite clinics. Not all sites reporting.

Date of report: 7-Sep-97

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recently consume alcohol, and his medical history was unremarkable.

His serum sodium was 127, potassium 4.3, and magnesium 1.3. Glucose, BUN and creatinine were in normal ranges. Urinalysis showed a specific gravity of 1.005, moderate occult blood, and trace ketones. ABGs on 100 percent oxygen were pH of 7.15, pO2 of 93 and a pCO2 of 38. A CT scan of the head and a chest radiograph were reported as normal.

He was admitted to the intensive care unit for severe hyponatremia complicated by seizure activity. An MRI was normal, and an EEG was consistent with metabolic encephalopathy. After several days, his electrolytes gradually normalized. He was discharged without residual neurologic deficits.

Case #3, Fort Jackson, South Carolina: On 28 July 1997, a 20 year-old native American soldier from North Dakota was in his third week of basic combat training when he was hospitalized with hyponatremia and generalized seizures. On the day of admission, he engaged in vigorous physical activities while consuming approximately two canteens of water per hour. In the afternoon, he complained of nausea, and in response, he was instructed to drink more water. He consumed approximately seven liters of water in a short period, his nausea worsened, and he vomited. He returned to the barracks but fell from his bunk during an apparent seizure.

He was transported to a local hospital in *status epilepticus*. He was placed on mechanical ventilatory support, treated with phenytoin intravenously, and admitted to the intensive care unit. A CT scan of the head revealed no intracranial abnormalities. Laboratory assessment documented serum sodium of 124, potassium of 3.2, and serum osmolality of 259. Infusion of 3%, followed by normal, saline resulted in brisk diuresis and resolution of symptoms. He was discharged on the fourth hospital day awake, alert, and asymptomatic.

Case #4, Fort Jackson, South Carolina: On 28 July 1997, a 19 year-old female basic trainee was admitted to the hospital with headache, nausea, vomiting, and fatigue. At approximately 1330 hours on the afternoon of admission, she began to vomit. During the next 1.5 hours, she drank approximately 10-12 canteens of water; thus, in the eight-hour period prior to her admission, she consumed 18 to 20 canteens of water. At the hospital, her condition rapidly deteriorated to general obtundation and disorientation. Her serum sodium was 121. She was admitted to intensive care where she received 0.9 normal saline intravenously.

By the second hospital day, her serum sodium was 131, and her neurologic deficits were completely resolved. She was discharged on the third hospital day.

Case # 5, Fort Jackson, South Carolina: On the evening of 13 August 1997, a 19 year-old white male basic trainee from Texas was hospitalized for nausea, dizziness, and generalized seizures. On the day of admission, the soldier's unit trained at the rifle range as the heat index rose to category 4 (WBGT: $88.0^{o} - 89.9^{o}$). After lunch, he consumed approximately 10 canteens of water in approximately four hours to prevent dehydration. Later in the afternoon, he became tired, disoriented, and nauseated. When he vomited, he was taken by his drill instructor to the hospital.

In the emergency room, he had a generalized seizure that lasted approximately one minute. At the time, his serum sodium was 123, blood pressure was 157/85, pulse 107, respirations 28, and temperature 95.5. His CXR appeared normal. He had no other significant abnormalities on physical examination.

He was doing well on the medical ward and was expected to return to duty after a brief treatment course.

Reports submitted by William P. Corr III, MAJ, MC, and Thomas Garigan, MAJ, MC, Fort Benning, Georgia; John Barson, LTC, MC, Fort Leonard Wood, Missouri; and Rose Marie Hendrix, LTC, MC, Fort Jackson, South Carolina.

Outbreak Investigation

Hyponatremia associated with heat stress and excessive water consumption: Outbreak investigation and recommendations

Armywide hospitalization experience: To assess the recent Armywide experience with regard to hyponatremia secondary to excessive water consumption, AMSA identified all hospitalizations among soldiers or West Point cadets in which either the primary discharge diagnosis was "hyposmolality and/or hyponatremia" (ICD-9 code 276.1) or the discharge diagnoses (up to 8 for each hospitalization) included both 276.1 and "fluid overload" (ICD-9 code 276.6) or "effects of heat" (ICD-9 992.0 - 992.9). Between 1989 and 1996, there were 125 hospitalizations that met these surveillance case criteria.

During that period, there were an average of 15.6 cases annually (range: 10-26 per year). More than 80% (n=103) of cases were among white soldiers, and approximately 85% (n=106) were among men.

Peaks in incidence occurred during summers approximately every two years, i.e., 1990, 1992, 1993, 1995 (figure 1, page 3). Nearly 85% (n=105) of cases occurred in the five month period between May and September, with the most cases occurring in July (n=38) (figure 2).

More cases occurred at Fort Benning (n=50) than any other post. In fact, 40% of cases Armywide occurred at Fort Benning. The Army's six basic training posts — Benning, Jackson, Sill, Wood, Knox, and McClellan — were among the eight installations with the highest number of cases (figure 3, page 10). Nearly one third (n=39) of cases had less than 3 months of service, and approximately 40% (n=49) were in the most junior ranks (PV1, PV2, cadet, 2LT).

Fort Benning Response: In response to the recent cluster of cases, the Martin Army Community Hospital established a multi-disciplinary Fort Benning heat group to document the incidence and nature of heat-related injuries and to determine risk factors for and methods of preventing and treating them (including hyponatremia secondary to excessive water consumption). Among other actions, the group revised Fort Benning policies regarding water consumption during training in heat stressful conditions. They articulated new guidelines for field treatment of soldiers with heat symptoms, and they formulated stricter guidelines for evacuating soldiers to definitive medical care when they do not

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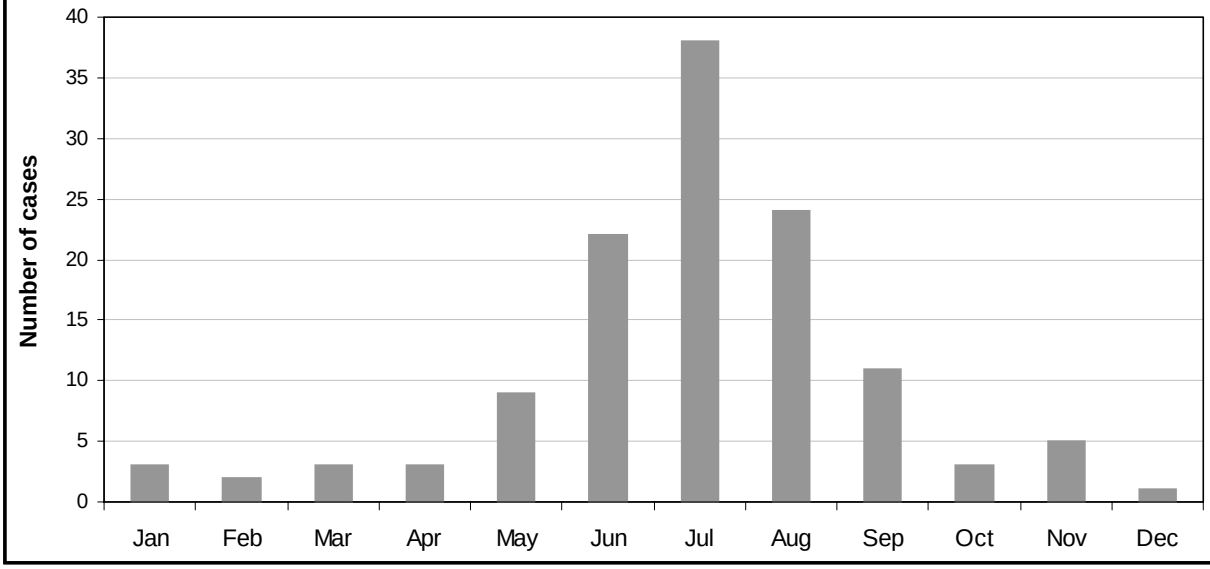
Figure 2. Hyponatremia hospitalizations among active duty Army, by month of admission, 1989-1996



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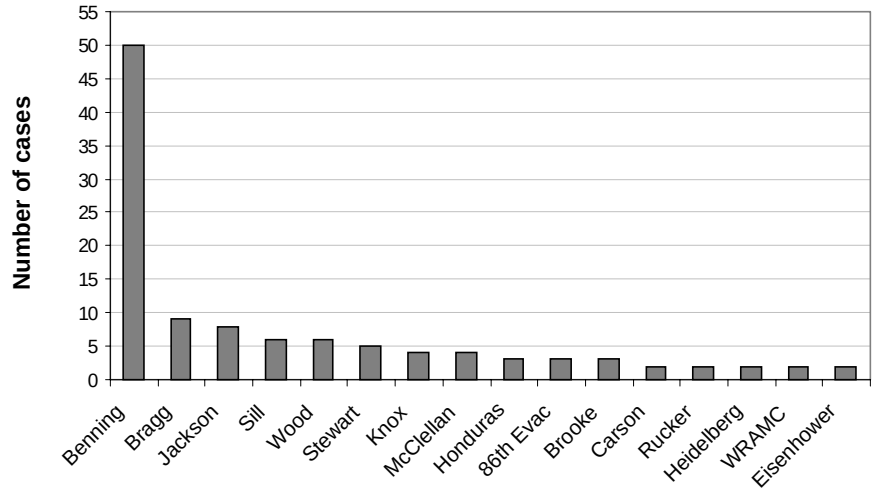
rapidly respond. In addition, the Fort Benning heat group designed and is conducting a study of randomly selected platoons of infantry trainees to assess the distribution and determinants of serum sodium concentrations and its change over the course of a training day. Finally, the Fort Benning group requested the assistance of a multidisciplinary team of consultants to provide scientific advice and oversight to policy, practice, and research initiatives.

Figure 3. Hyponatremia hospitalizations among active duty Army, by MTF, 1989-1996



Epidemiology Consultation (EPICON): On 27-29 August 1997, a team with expertise in the areas of epidemiology, physiology, nephrology, and preventive medicine traveled to Fort Benning to review the current status of and to suggest changes in local and Army-wide heat injury prevention doctrine, policies, and practices.

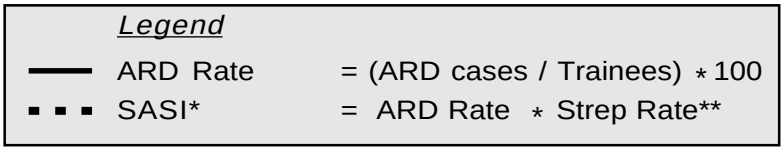
Reviews of recent case reports and published literature in relation to normal physiologic adaptations to heat stress and hydration confirmed that excessive free water consumption in the interest of preventing heat casualties was the common cause of the recent cases of hyponatremia in military trainees. As a result, the team recommended that Army heat injury prevention and water doctrine be revised to ensure that appropriate hydration is maintained during physically demanding activities in hot environments – while protecting against the much less common but potentially significant threat of overhydration.

Editorial comment: Adequate water consumption is essential to prevent heat casualties during vigorous activities (e.g., military training) in hot environments. The practice of "water discipline"— enforced, systematic water consumption by all members of a military unit – regardless of individual preference or thirst, has been proven to be successful in preventing heat related injuries in training and military operational settings. Nonetheless, the recent cases of clinically significant hyponatremia at multiple training sites during a nationwide heat wave highlight the potential dangers of excessive water consumption to prevent or treat heat injuries.

Unfortunately, the early signs and symptoms of heat injury and of hyponatremia secondary to excessive water consumption are similar. In the absence of restrictions regarding water consumption, cases suggestive of early heat injury may be treated in the field by "first responders" with copious amounts of free water.

Since the stomach can empty water to the intestines (the site of its absorption) at a maximum rate of approximately 1.2 liters per hour (with significant individual variability), it is of no value under any circumstances to drink more than 1.5 to 2 liters per hour. Higher water intakes are likely to cause nausea, vomiting, and in severe cases, hyponatremia. For this reason, interim Fort Benning policy limits the consumption of water to one canteen per 30 minutes. If soldiers with heat symptoms do not recover after an hour (i.e., two canteens plus rest and cooling), they should be medically evacuated for definitive evaluation and treatment. In addition, soldiers who vomit two or more times during first aid for heat stress in the field should be medically evacuated. Armywide policy revisions reflecting these changes are expected in the near future.

ARD Surveillance Update



Ft Benning

Ft Jackson

Ft Knox

Ft Leonard Wood

Ft McClellan

Ft Sill

Figure III. ARD surveillance rates, submitted by Army TRADOC posts

* Strep/ARD Surveillance Index (SASI)

**Strep Rate= (GABHS(+) / Cultures) *100

Note: SASI has proven to be a reliable predictor of serious strep-related morbidity, especially acute rheumatic fever.

Deployment Surveillance

Hospitalizations, Operation Joint Endeavor, Bosnia
Part II. Hospitalization experience in diagnostic subcategories

In December 1995, the United States deployed a joint task force to Bosnia as part of a multinational peacekeeping mission called Operation Joint Endeavor (OJE). Summaries of the overall morbidity experience of US Army participants in OJE were presented in the MSMR (3:4 (June), 1997). For this report, we analyzed the hospitalization experience of OJE participants in diagnostic subcategories that were defined based on major organ systems affected or etiology.

Methods: Data sources and details of analytic methods were reported in Part I of the OJE analysis. In summary, complete data were available for 22,479 soldiers who deployed to and returned from OJE in Bosnia. For this analysis, all hospitalizations in OJE were assigned to diagnostic categories based on the ICD-9 code of the first listed diagnosis (which generally represents the primary reason for the hospitalization). Diagnostic categories corresponded to those specified in the Ninth Revision of the International Classification of Diseases (ICD-9) except that, to reduce the total number, hospitalizations in some ICD-9 categories were apportioned to others based on primary affected organ systems (for example, infectious and parasitic diseases were apportioned to respiratory, gastrointestinal, genitourinary) or were combined into a single "other" category (e.g., neoplasms; endocrine, nutritional, and metabolic immunologic diseases; diseases of blood and blood forming organs; congenital abnormalities; signs, symptoms, and ill defined conditions). Thus, for this analysis, hospitalizations in OJE were divided into seven categories: mental, circulatory, respiratory, digestive, genitourinary/pregnancy-related, injuries/musculoskeletal, and other.

General: Table 1 shows the number of hospitalizations, cumulative incidence ("attack rate") and relative incidence rates by category (compared to the category with the fewest hospitalizations and a relative rate = 1.0). During OJE deployment, the greatest number of hospitalizations were attributable to injuries/musculoskeletal conditions while mental disorders accounted for the fewest.

Temporal trends (figure, page 13): Because point estimates of category-specific weekly rates were relatively unstable, to assess temporal trends, we used "smoothed rates." For each week of the deployment, we calculated a rate based on the hospitalizations and the soldiers at risk during the week of interest plus the two weeks before and the two weeks following the week of interest. Thus, the rate for each week represents experience during a five week window that is centered on the week of interest. We then applied standard curve-fitting methods to describe general patterns of hospital-

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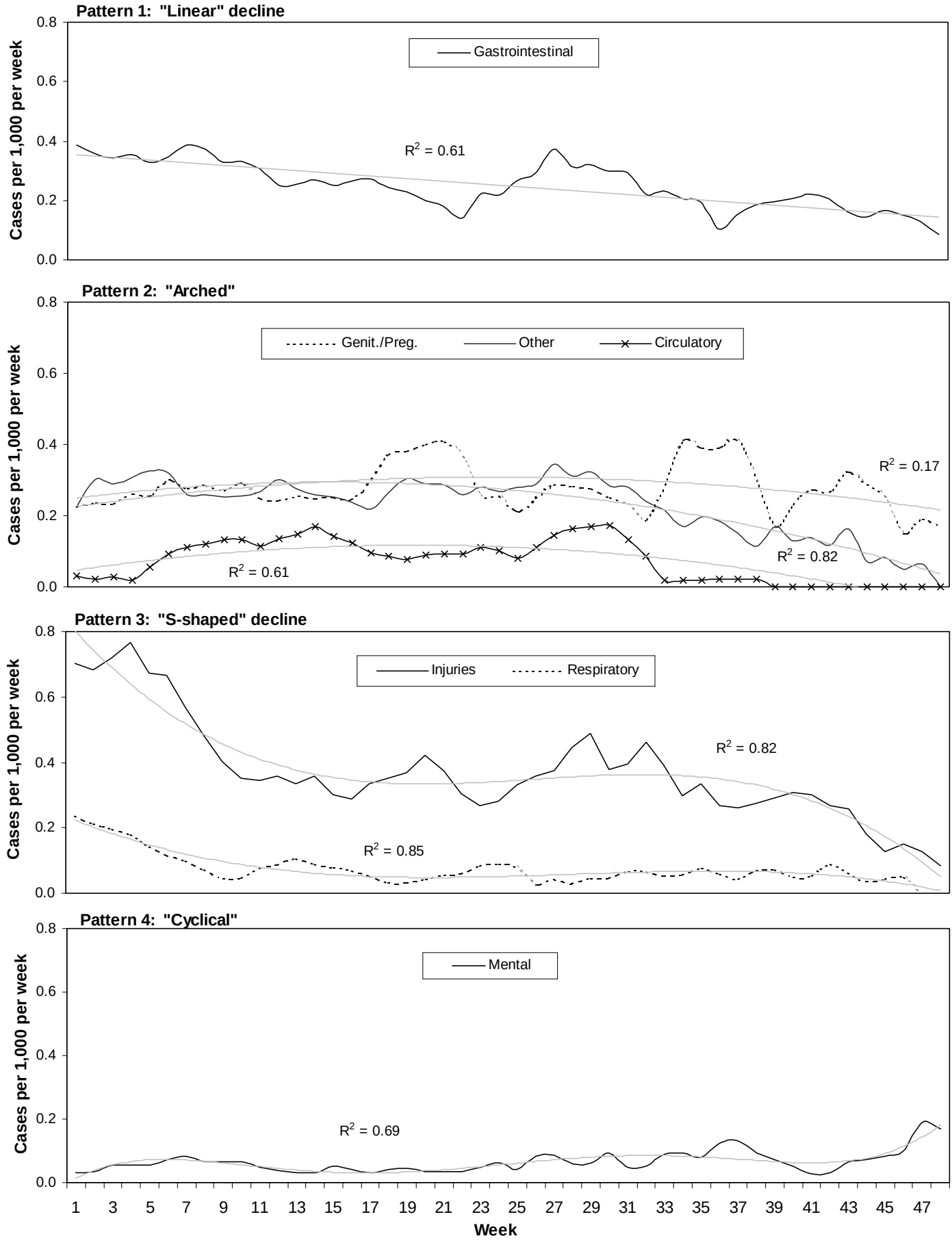
Table 1. Frequency, cumulative incidence, and relative risk by diagnositic category, OJE

Category	Number hospitalized	Cumulative incidence (per 1000) "attack rate"	Relative Risk
Mental	43	1.91	1.0
Circulatory	63	2.8	1.5
Respiratory	64	2.85	1.5
"Other"	183	8.14	4.3
Gastrointestinal	197	8.76	4.6
Genitourinary / pregnancy	204	9.08	4.7
Injury / musculoskeletal	301	13.29	7.0


Pattern 1: "Linear" decline
Gastrointestinal
R^2 = 0.61
Pattern 2: "Arched"
Genit./Preg.
Other
Circulatory
R^2 = 0.17
R^2 = 0.82
R^2 = 0.61
Pattern 3: "S-shaped" decline
Injuries
Respiratory
R^2 = 0.82
R^2 = 0.85
Pattern 4: "Cyclical"
Mental
R^2 = 0.69
Cases per 1,000 per week
0.0
0.2
0.4
0.6
0.8
1 3 5 7 9 11 13 15 17 19 21 23 25 27 29 31 33 35 37 39 41 43 45 47
Week

Continued from page 12

ization experience in specific categories. Four general patterns emerged:

(1) Pattern 1 ("linear decline"): Hospitalizations for gastrointestinal illnesses declined in a linear fashion throughout the deployment;

(2) Pattern 2 ("arch-shaped"): Hospitalizations for circulatory, genitourinary/pregnancy-related, and "other" disorders slowly increased during the early weeks of the deployment, peaked during the middle stages, and then declined in the latter weeks;

(3) Pattern 3 ("s-shaped decline"): Hospitalizations for injuries/musculoskeletal conditions and respiratory disorders were highest in the earliest weeks of the deployment, were relatively stable at lower rates through the middle stages, and then declined in the latter weeks;

(4) Pattern 4 ("cyclical"): Hospitalizations for mental disorders rose and fell cyclically throughout the deployment.

Proportional hazards regression analysis: As for part I of the analysis, we used Cox's proportional hazards regression model to estimate the strengths of independent associations between demographic characteristics (gender, race/ethnicity, and age) and prior hospitalization experience with category-specific hospitalization risk. Table 2 shows the results of category-specific multivariate regression analyses.

Gender: Females had significantly increased risks of hospitalizations for genitourinary (including pregnancy), respiratory, gastrointestinal and "other" disorders. Males did not have significantly increased risks of hospitalization for any individual category.

Prior hospitalization experience: Soldiers who were ever hospitalized in a military hospital prior to deployment had significantly higher risks of hospitalization in OJE – overall and for all diagnostic categories except for "mental disorders."

Age: Hospitalization risk for circulatory disorders significantly increased with age. In contrast, hospitalizations for genitourinary/pregnancy-related and for gastrointestinal disorders were significantly higher among younger soldiers.

Racial/ethnic: Black and hispanic soldiers compared to white had significantly increased risks of hospitalization for respiratory illnesses, genitourinary/pregnancy-related disorders, and injuries/musculoskeletal conditions. White non-hispanic soldiers were not at significantly increased risk for hospitalization for any single diagnostic category.

Most frequent diagnoses (table 3): Nearly one third of all OJE-related hospitalizations were attributable to the ten most frequent diagnoses (based on 3-digit ICD-9 codes). Injuries, musculoskeletal conditions, and gastrointestinal illnesses accounted for five of the top seven most frequent causes of hospitalizations (table 3).

Editorial comment: Analyses of OJE-related hospitalizations in diagnostic subgroups provide unique and potentially useful insights.

Table 2. Adjusted relative risks of hospitalization, active duty soldiers, Operation Joint Endeavor

Category	Gender (female:male)	Prior hospitalization (yes:no)	Age group (<20:20-24:>25)	Race/ethnicity (bnh or hisp:wnh)
Mental	1.47	1.73	0.89	1.06
Circulatory	0.43	2.18**	3.21**	0.92
Respiratory	1.90*	1.80*	0.77	1.88*
Gastrointestinal	1.61*	1.96**	0.76*	0.93
Genitourinary	4.01**	1.84**	1.26	1.35
Injury / musculoskeletal	0.82	1.90**	0.91	1.52**
Other	1.66*	2.21**	0.90	1.00
Overall	2.38**	1.95**	1.22**	1.16**

* p value < 0.05, ** p value < 0.01

Normal pregnancy excluded from this analysis

While hospitalizations overall followed a generally linear declining trend (see Part I), temporal patterns of hospitalization risks varied in various diagnostic subgroups. In general, there were four patterns (figure, page 13): patterns one and three were associated with declines over time from relatively high rates early in the deployment; pattern two was associated with relatively higher rates in the mid-stages of the deployment; and pattern four was characterized by frequent, relatively low amplitude rises and falls throughout the period.

The greatest number of hospitalizations by far were attributable to injuries and musculoskeletal conditions (particularly related to the back, knees, and legs). Hospitalizations in this category were seven times more frequent than those for "mental" conditions and approximately 1.5 times more frequent than those for gastrointestinal, genitourinary (including pregnancy-related), or "other" conditions.

Hospitalization rates for injuries/musculoskeletal conditions followed an "S-shaped decline" pattern — rates were highest by far among soldiers during their few weeks in the theater. This finding may reflect the significance of health and safety threats inherent to developing and improving (in contrast to simply maintaining) theater infrastructure (e.g., roads, bridges, basecamps) as well as those associated with living and operating in unfamiliar environments.

Of specific diagnoses (by 3-digit ICD-9 code), "normal pregnancies" accounted for the highest number of hospitalizations; however, this finding must be interpreted with great caution. Almost by definition, "normal" pregnancies are not associated with significant morbidity — indeed, in deployment settings, hospitalizations for normal pregnancies are more reflective of administrative than medical concerns. Thus, analyses that attempt to elucidate the distribution and determinants of morbidity during deployments should evaluate hospitalizations for "normal" states with special consideration.

In nearly every diagnostic category, soldiers who had ever been hospitalized were at significantly greater risk of hospitalization in OJE than those without such histories. Soldiers must be healthy and fit prior to deployment in order to endure the physical and psychological stresses associated with overseas, potentially hostile, military operations. The findings from OJE suggest that the rehabilitation and physical conditioning of soldiers with chronic medical conditions or with recent hospitalizations for acute conditions may have special military readiness implications.

Table 3. Most frequent primary diagnosis (3 digit ICD-9 code)

Diagnosis	Number of Hospitalizations	Category
Normal pregnancy	87	Genitourinary
Noninfectious gastroenteritis and colitis	51	Gastrointestinal
Unspecified disorder of the back	38	Injury / musculoskeletal
Symptoms involving the abdoman and pelvis	29	Gastrointestinal
General symptoms	27	Other
Inguinal hernia	23	Gastrointestinal
Injury, unspecified	21	Injury / musculoskeletal
Cellulitis, abscess	21	Other
Viral and chlamydial infections of unspecified	18	Other
Sprains / strains of knee / leg	17	Injury / musculoskeletal

Annual summary

Heat injuries in active duty soldiers, 1990-1996

Between the calendar years 1990-1996, there were 1399 hospitalizations for heat injuries among active duty soldiers. This report summarizes the demographic characteristics of these cases, as well as analyzes trends in admitted cases.

Methods: To determine the significance of relative excesses or deficits of heat injuries in various demographic subgroups, we compared observed cases to expected cases. Expected numbers of cases were calculated based on the assumption that heat injuries should be distributed among demographic subgroups in proportion to their representation in the general population of the Army. Hence, expected numbers of cases for various subgroups were calculated by multiplying the proportional representation of each subgroup in the Army by the total number of heat injury cases. The statistical significance of variations between observed and expected numbers were then assessed based on the Poisson distribution (statistical significance was defined as $p < .05$) for home of record data and the binomial distribution for the other demographic variables.

General: There has been an overall decrease in the rate of heat injury hospitalizations, from 0.37 per thousand in 1990 to 0.19 per thousand in 1996 (figure 1). Of all cases hospitalized, 258 (18%) were diagnosed as heat stroke, 867 (62%) were diagnosed with heat exhaustion, and 274 (20%) had other heat related codings, including unspecified. With the exception of 1991, which is skewed by an "outbreak" of 125 admitted cases of heat exhaustion from Ft. Stewart, the proportional distribution of cases is notable for a trend toward increasing severity of illness. Whereas in 1990 only 18% of admitted cases had heat stroke, in 1996 38.9% of heat related admissions were for heat stroke (Chi-square for linear trend, $p < .0005$).

Gender: Females constitute approximately 12% of the active duty Army population, and they

Figure 1. Hospitalization rates for heat injuries, 1990-1996

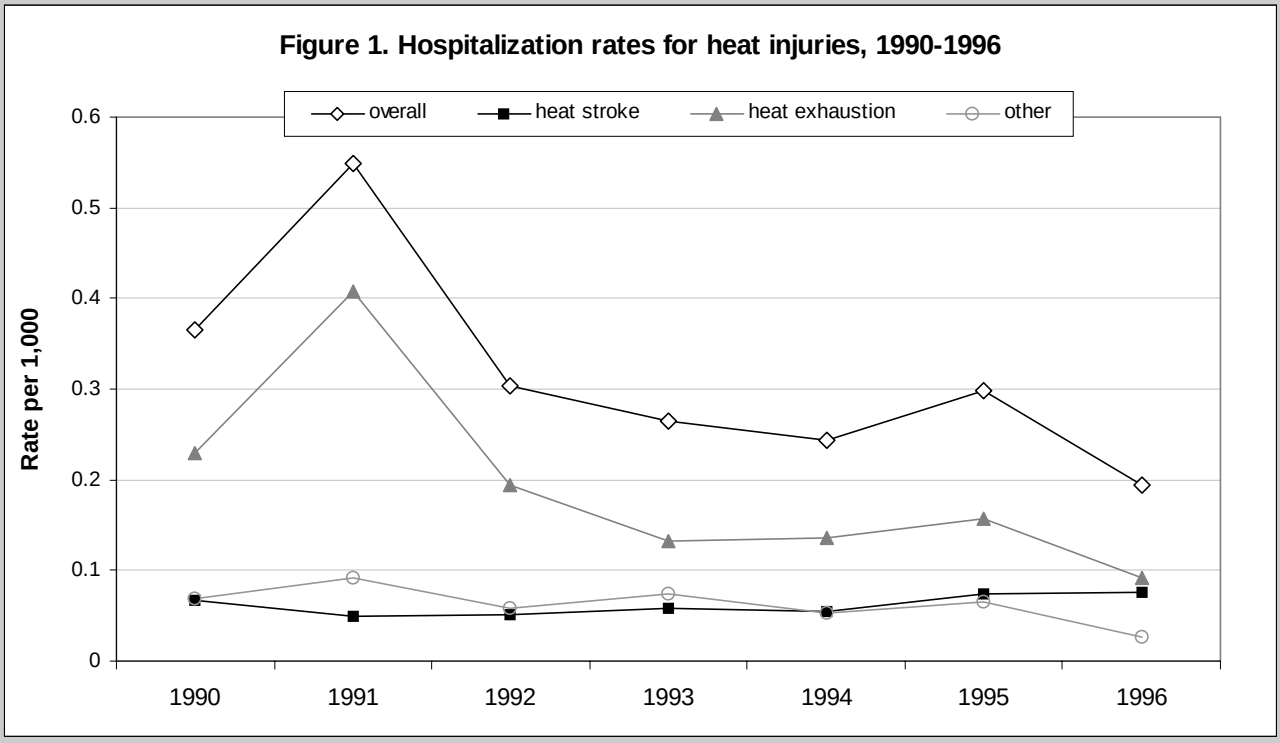
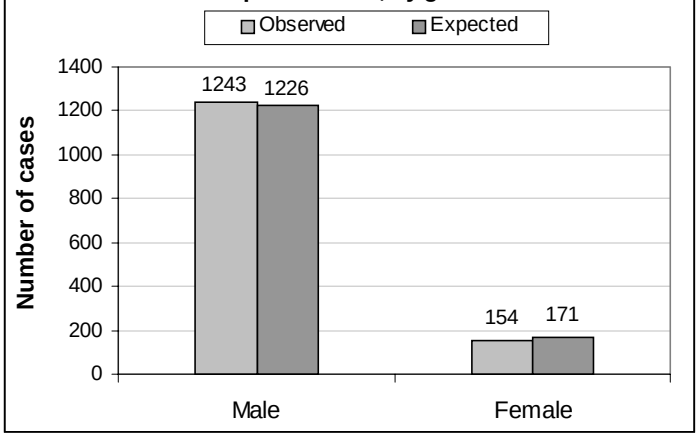


Figure 2. Observed vs. expected heat injury hospitalizations, by gender



represented 11% of the admitted heat cases, a difference which was not statistically significant (figure 2).

Race/ethnicity: Race/ethnicity is divided into the categories of "white", "black", "hispanic" and "other". Hispanics were found to have the highest risk of heat injury, followed by whites. Individuals in the category of "other" were the least likely to be admitted for heat injury, and blacks were also statistically less likely to be admitted with this diagnosis (figure 3).

Age: Age was found to be a statistically significant predictor of heat injury admission. Soldiers younger than the 25-29 year age range were the most likely to be admitted for heat injury, while soldiers older than that age range had a much lower likelihood of being admitted, with risk decreasing with increasing age (figure 4, page 18).

Residence prior to entering Army service: Military Entrance Processing Station (MEPS) records documented states of residence prior to entering Army service for 1037 (74%) of the 1399 admitted heat injury cases. While there was some variation between states when viewed overall and stratified by race, the differences did not reach statistical significance. However, it is notable that the upper midwestern states had more cases than expected while the northeast and southwest had fewer (figure 5).

Summary: While the rate of admission for heat exhaustion and "other" heat diagnoses has decreased over the last seven years, the rate of heat stroke has remained constant. It is reasonable to assume that nearly all cases of heat stroke are admitted, therefore admission rates for heat stroke most closely indicate actual incidence trends. The substantial decreases seen in the less medically serious cases are likely to reflect changes in hospital admission policies in addition to actual changes in incidence.

Home of record and gender were not found to correlate with admission rates, but race and age were both significantly associated with heat injuries. The reasons for the racial differences are unclear, but hispanics in this analysis had a higher rate of admission than other racial groups. The increased risk in the lower age groups probably reflects greater activity levels in hot environments by young soldiers.

Heat injuries remain an important cause of lost duty time and hospitalization during the summer months. Continued attention to "water discipline" and work-rest cycles is necessary to ensure that heat casualties, a preventable cause of morbidity, are kept to a minimum.

Figure 3. Observed vs. expected heat injury hospitalizations, by race/ethnic

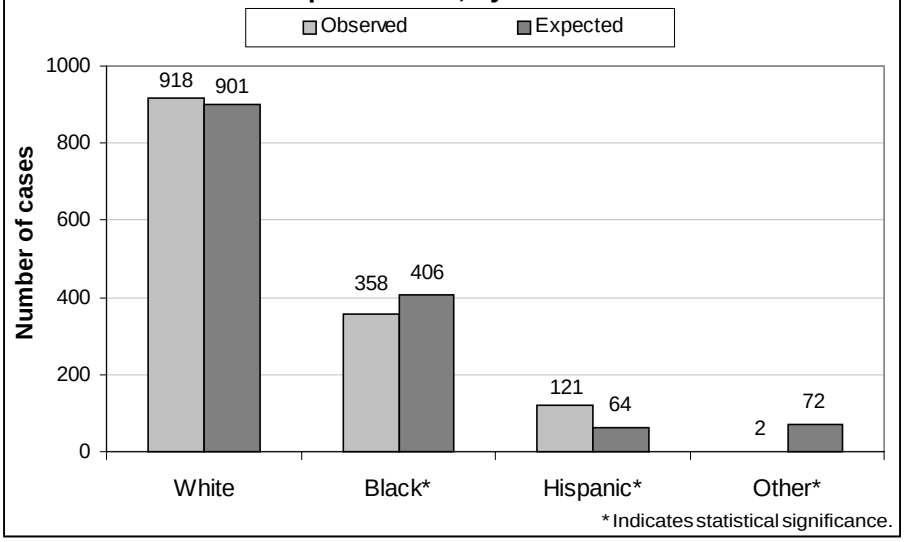
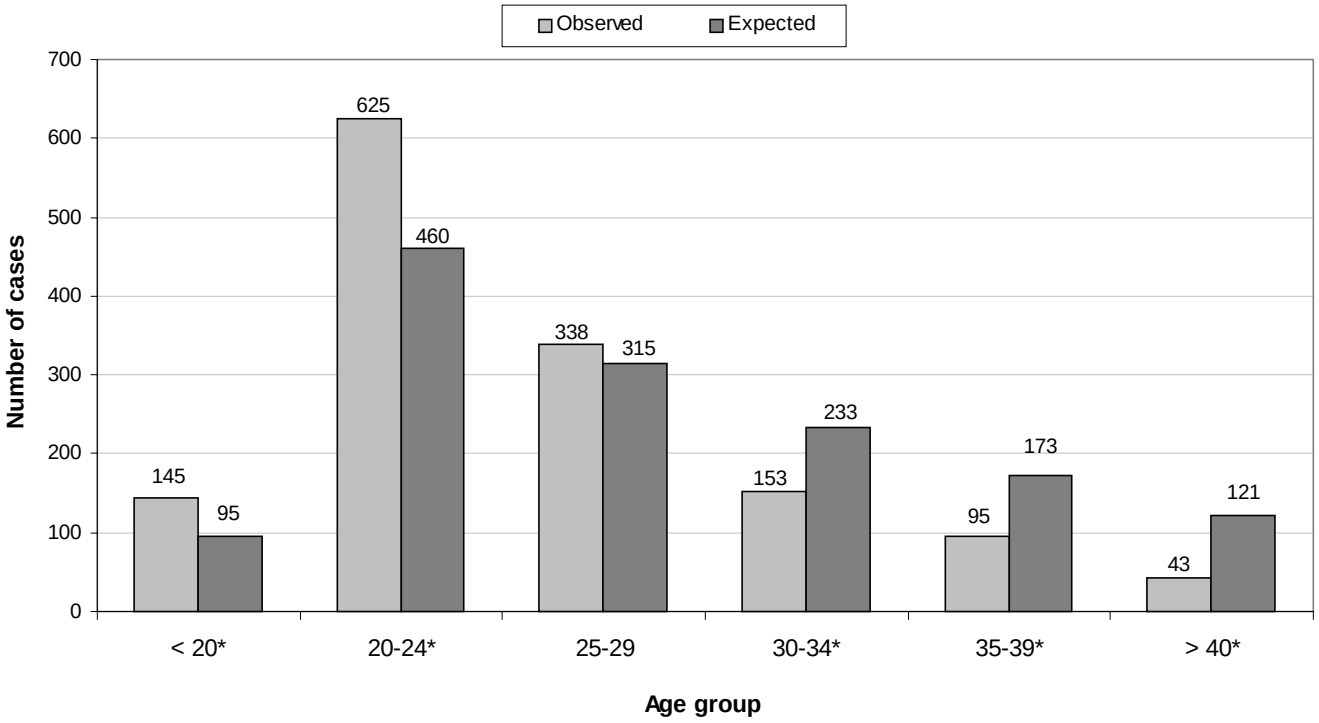
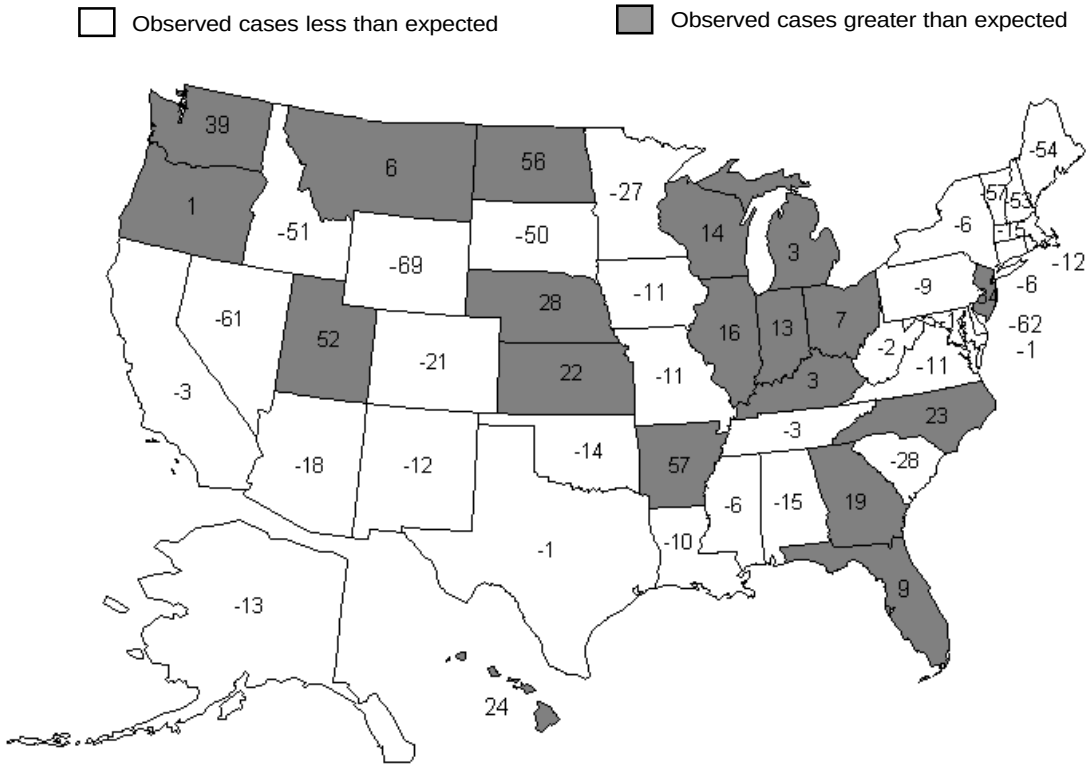


Figure 4. Observed vs. expected heat injury hospitalizations, by age group



* Indicates statistical significance.

Figure 5. Percent excess/deficit of heat related injuries, by residence prior to service



The number in each state indicates percent excess/deficit

TABLE III. Cases of hospitalized heat injuries, active duty Army*

Reporting MTF/Post**	1990	1991	1992	1993	1994	1995	1996	Total
NORTH ATLANTIC RMC								
Walter Reed AMC	-	-	-	-	-	-	1	**1**
Aberdeen Prov. Ground, MD	-	-	-	-	-	-	-	**0**
FT Belvoir, VA	1	-	2	1	1	1	1	**7**
FT Bragg, NC	19	49	15	17	11	19	19	**149**
FT Drum, NY	-	-	-	-	-	-	-	**0**
FT Eustis, VA	3	1	1	1	1	-	3	**10**
FT Knox, KY	3	18	2	2	3	-	2	**30**
FT Lee, VA	9	1	2	3	1	1	-	**17**
FT Meade, MD	1	8	1	-	-	-	-	**10**
West Point, NY	1	1	-	-	-	-	-	**2**
SOUTH CENTRAL RMC								
Brooke AMC	3	4	1	6	-	-	-	**14**
FT Carson, CO	1	-	-	-	-	-	2	**3**
FT Hood, TX	6	3	4	7	1	8	5	**34**
FT Leavenworth, KS	-	-	-	-	-	1	-	**1**
FT Leonard Wood, MO	6	6	2	7	3	-	3	**27**
FT Polk, LA	12	6	6	3	2	15	2	**46**
FT Riley, KS	9	-	2	-	1	2	-	**14**
FT Sill, OK	12	6	5	7	7	13	5	**55**
Panama	33	48	22	14	19	14	-	**150**
SOUTHEAST RMC								
Eisenhower AMC	1	4	4	-	2	2	4	**17**
FT Benning, GA	59	36	40	33	30	46	24	**268**
FT Campbell, KY	13	10	6	11	5	8	2	**55**
FT Jackson, SC	13	20	9	4	6	-	1	**53**
FT McClellan, AL	3	2	1	-	6	-	-	**12**
FT Rucker, AL	2	2	-	2	5	2	2	**15**
FT Stewart, GA	4	137	28	22	2	4	5	**202**
SOUTHWEST RMC								
Wm Beaumont AMC	6	4	10	1	4	-	1	**26**
FT Huachuca, AZ	-	-	-	-	1	-	-	**1**
FT Irwin, CA	7	15	13	2	2	2	1	**42**
NORTHWEST RMC								
Madigan AMC	2	1	-	1	1	-	1	**6**
FT Wainwright, AK	1	-	-	1	-	1	1	**4**
PACIFIC RMC								
Tripler AMC	3	-	1	1	8	5	5	**23**
OTHER LOCATIONS								
Europe	22	5	8	3	4	5	2	**49**
Korea	1	3	5	1	6	4	-	**20**
Other MTF	13	9	4	3	2	2	3	**36**
	269	**399**	**194**	**153**	**134**	**155**	**95**	**1399**

* Based on date of admission

Date of Report: 7-Sep-97

Source: Standard Inpatient Data System, USA Patient Administration Systems and Biostatistical Activity, Fort Sam Houston, TX

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