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Report No. 02-32

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A DESCRIPTIVE ANALYSIS OF MEDICAL ENCOUNTERS ABOARD 15 NAVY SURFACE SHIPS HOME-PORTED IN SAN DIEGO

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Report No. 02-32 was supported by the Bureau of Medicine and Surgery, Washington, DC, under Work Unit No. 0604771N-60001. The views expressed in this report are those of the authors and do not necessarily reflect the official policy or position of the Department of the Navy, Department of Defense, or the United States Government. Approved for public release; distribution unlimited. This research has been conducted in compliance with all applicable Federal Regulations governing the protection of human subjects in research.

ABSTRACT

There has been no mechanism for comprehensively monitoring shipboard illnesses and injuries in over a decade. Electronic medical encounter records from the Shipboard Non-Tactical ADP Program (SNAP) Automated Medical System (SAMS) installed aboard individual vessels are now available and were acquired for this descriptive study of sick-call visits aboard 15 San Diego, California, home-ported Navy ships. An extensive examination of ICD-9-CM diagnostic and demographic frequencies is presented. Of the 5,378 encounters examined, the most frequent major categorical complaints were respiratory (31%), injury and musculoskeletal (29%), dermatologic (9%), and infectious or parasitic illnesses (8%). Frequency of diagnosis was largely unrelated to gender, although men were more apt to be seen for sprains and strains and women for genitourinary conditions and reproductive services. Of 1,307 encounters that resulted in either modified/light duty or lost work, 60% were caused by upper respiratory infections (23%), intestinal disease (19%), and sprains/strains (18%). This is the first in-depth analysis of SAMS data obtained from a diverse sample of surface ships, and it demonstrates the substantial surveillance capability now available to continuously monitor shipboard health and readiness. Such surveillance, if monitored actively, should enhance our ability to intervene early, identify modifiable risks, assess prevention and control efforts, and improve the allocation of limited resources.

SUMMARY

Problem

Monitoring a crew's health is vital whether our forces are deployed or at home. There has been no mechanism, however, for comprehensively monitoring shipboard illnesses and injuries in over a decade. The only remaining indicators of shipboard morbidity are either manually compiled disease and non-battle injury reports, filed by ships only during periods of deployment to certain geographic areas, or sporadic studies typically focused on specific conditions or populations aboard isolated vessels.

Objective

This study was undertaken to explore the nature of medical encounters occurring aboard U.S. Navy ships and demonstrate the potential surveillance capability now available to continuously monitor shipboard health and readiness using Shipboard Non-Tactical ADP Program [SNAP] Automated Medical System (SAMS) data.

Method

Electronic medical encounter records from SAMS installed aboard individual vessels were acquired for this descriptive study of sick-call visits aboard 15 San Diego, California home-ported Navy surface ships during a 12-month period between March 1, 1999, and February 29, 2000. The vessels include 7 amphibious ships, 5 frigates, 2 destroyers, and 1 cruiser. Frequencies and cross-tabulations of key variables, including ICD-9-CM diagnoses, demographics, pay grade, ship type, and duty status dispositions were performed.

Results

There were 5,378 qualified encounters recorded in the 12-month study period. Women were seen at 18% and men at 82% of these visits; officers at 4% and enlisted (including warrant officers) at 96% of visits. The most frequent major categorical complaints were respiratory (31%), injury and musculoskeletal (29%), dermatologic (9%), and infectious or parasitic illnesses (8%). Frequency of diagnosis was largely unrelated to gender, although men were more apt to be seen for sprains and strains and women for genitourinary conditions and reproductive services. Of 1,307 encounters that resulted in either modified/light duty or lost work, 60% were caused by upper respiratory infections (23%), intestinal disease (19%), and sprains/strains (18%). The older the patient and the higher his/her rank, the less often duty was compromised.

Conclusions

The leading reasons for patient visits in this study are consistent with previous research findings. This study demonstrates the potential for improved SAMS-supported surveillance to promote shipboard health and readiness. Preventive medicine personnel, commanders, medical educators, and medical planners should find such data, and the surveillance information they generate, invaluable in efforts to improve the health of Navy and Marine Corps personnel.

Introduction

Illnesses and injuries aboard U.S. Navy ships concern both the line and medical communities. Monitoring a crew's health is vital whether our forces are deployed or at home.1 Until the late 1980s shipboard medical encounters were tracked using hand-tallied monthly Medical Services and Outpatient Morbidity Reports provided by ships' medical departments.[2] Since this system was retired, there has been no mechanism for comprehensively monitoring shipboard illnesses and injuries. The only remaining indicators of shipboard morbidity are either manually compiled disease and non-battle injury (DNBI) reports, filed by ships only during periods of deployment to certain geographic areas, or sporadic studies typically focused on specific conditions or populations aboard isolated vessels.[3-7]

Today a mechanism exists to capture comprehensive, year-round shipboard morbidity data. An automated medical administrative management system known as SAMS (the Shipboard Non-Tactical ADP Program [SNAP] Automated Medical System) is now used to capture such information, but an analysis of SAMS data from surface ships has not been published to date. Capitalizing on this potentially rich store of morbidity data, this study was undertaken to explore the nature of medical encounters occurring aboard U.S. Navy ships. Records from 15 Pacific Fleet ships were examined and the findings are presented in this paper.

Background

There is a scarcity of shipboard outpatient research in the literature except for studies confined to specific platforms such as aircraft carriers and submarines. This may be due to the fact that carriers have greater populations, more medical staff, and are equipped with the Composite Health Care System, enabling the electronic capture of their outpatient visit information. In a 3-month study aboard a carrier in 1994 by Vidmar et al., the disorders with the highest incidence rates involved (in descending) order skin, respiratory, digestive, injuries, and musculoskeletal systems.[3] Krentz examined injuries aboard a carrier during a 6-month deployment and found that men sought attention most often for low back pain, tendonitis, and sprains. Women were

most often afflicted with muscle strains and stress fractures. Over one third of identified injuries resulted in lost duty. Musculoskeletal injuries were most often associated with lost duty, especially those involving the lower extremities, neck, and back.[6]

When encounters electronically recorded in 1997 and 1998 involving male crew members aboard 136 submarine patrols were analyzed by Thomas and colleagues, injuries accounted for 30% of the initial visits to medical providers. Injuries were followed by respiratory (16%), skin and subcutaneous conditions (12%), unclassifiable symptoms and ill-defined conditions (7%), conditions of the digestive system (6%), and nervous system and sense organs (6%). The more finite conditions presenting most frequently within these larger diagnostic classifications included open wounds and sprains/strains (43% and 17% of all injuries, respectively), upper respiratory illnesses (URI)s (88% of all respiratory conditions), and minor skin infections and ingrown toenails (36% and 23% of all dermatologic conditions, respectively). Ill-defined conditions encompassed a wide range of symptoms, such as fainting, headache, chest pain; nausea, vomiting, and heartburn; skin swelling and edema, and abdominal pain. In examining disposition status, 70% of patients were able to resume full duty, and 28% were assigned light or no duty.[8]

The last comprehensive published report on shipboard illnesses and injuries involving both men and women serving on a variety of platforms was conducted in 1990 by Nice and Hilton.[9] Summary data representing 62,671 sick call visits aboard 20 ships and detailed data from 12,542 individual visits were analyzed. Crew members saw medical staff primarily for injuries, musculoskeletal problems, or effects of external exposures (27%), health services (25%), infectious/parasitic (11%), respiratory (10%), and skin and subcutaneous tissue conditions 4 of 19 2/18/2003 2:45 PM (7%). When encounters were aggregated into three groups: (1) illnesses/ disorders; (2) health services, and (3) injuries, musculoskeletal problems, or effects of external exposures, their distribution was 48%, 25%, and 27%, respectively.

Garland and colleagues investigated shipboard medical encounters and, in a 1996 unpublished report, presented findings from 23 ships. Crew members sought medical

attention chiefly for injuries, respiratory conditions, infectious and parasitic diseases, and health related services. Genitourinary disorders disproportionately brought women to sick bay, while skin conditions more often affected men. The principal reason for sick-call visits by women were for health services. These visits were for general medical examinations, contraceptive management, Papanicolaou (Pap) smears, and pregnancy-related needs.[10]

In the present study we examined more than 5,000 medical encounters occurring aboard 15 U.S. Navy surface ships in the Pacific Fleet. To complete this investigation, we collected SAMS data and performed descriptive analyses using standard statistical software.[11] This is the first in-depth analysis of SAMS data obtained from a diverse sample of surface ships, and it demonstrates the substantial surveillance capability now available to continuously monitor shipboard health particularly before, during, and after deployment. Continuous and comprehensive surveillance throughout a member's period of service is the Department of Defense (DoD) current long-range plan.[12,13] Such surveillance can enhance our ability to intervene early, identify modifiable factors that influence health status, assess prevention and control efforts targeting those factors, and improve the allocation of limited resources.

Methods

Population

The study population consisted of crew members receiving shipboard clinical services during a 12-month period between March 1, 1999, and February 29, 2000. The 15 ships on which they served included the *USS Anchorage* (LSD-36), *USS Antietam* (CG-54), *USS Cleveland* (LPD-7), *USS Comstock* (LSD-45) *USS Curts* (FFG-38) *USS Decatur* (DDG-73) *USS Duluth* (LPD-6) *USS George Philip* (FFG-12) *USS John A Moore* (FFG-19), *USS Kinkaid* (DD-965) *USS Mount Vernon* (LSD-39) *USS Pearl Harbor* (LSD-52) *USS Sides* (FFG-14) and the *USS Tarawa* (LHA-1). These ships are part of the Pacific Fleet home-based in San Diego, California, and were chosen because their encounter records contained the most complete diagnostic information. The vessels include 5 frigates (FFGs), 4 dock landing ships (LSDs), 2 amphibious transport ships (LPDs), 2 destroyers (DDGs), 1 cruiser (CG), and 1 amphibious assault ship (LHA).

Only active U.S. Navy personnel were studied. Encounters involving embarked Marines, Coast Guard, and Navy reserve personnel were excluded.

Data Collection

Records were extracted from SAMS, a PC-based stand-alone system installed on shipboard computers. SAMS, the electronic system selected for use by shipboard medical departments to automate medical encounter documentation,[14] has been fully described by Thomas et al.[8] Data extracted from SAMS were then written to diskette using the Epidemiological Wizard (EPIWIZ), a Microsoft® Excel-based program specifically created to summarize SAMS medical encounter data.[15] Once in EPIWIZ, diagnostic coding procedures were performed and key fields were then selected to produce the data set used in this study.

The majority of SAMS electronic records captured by EPIWIZ contained an International Classification of Diseases, 9th Revision, Clinical Modification (ICD-9-CM) diagnostic code16 assigned by the ship's medical department using the SAMS look-up table option. A software routine was created at Naval Health Research Center (NHRC) to supply diagnostic coding where possible when codes were missing. This routine searched for and mapped key words and phrases contained in SAMS' subjective, objective, assessment, and plan (SOAP) note fields to appropriate ICD-9-CM codes. Each coded condition was assigned to one of 17 major ICD-9-CM categories and to one of 90 ICD-9-CM subcategories that consist of 3-digit groupings (e.g., 001-009 = intestinal infectious diseases). Each discrete diagnosis (3-5 digit deep ICD-9-CM code) was then assigned diagnostic text corresponding to its more numeric code. To ensure that an incidence of a given condition manifested by an individual was counted just once, only information collected at the initial visit was used. Hence, follow-up visits and encounters without diagnostic coding were not included.

Results

There were 5,378 qualified encounters recorded in the 12-month study period. Women were seen at 18% and men at 82% of these visits; officers at 4% and enlisted (including warrant officers) at 96% of visits. The distribution of encounters by gender, age, paygrade, and ship type is presented in Table I.

Table I. Distribution of sickcall visits by demographic, career, and ship-related variables.

	No.	%
Gender		
Women	948	(18)
Men	4,430	(82)
Age		
17-19	478	(09)
20-24	2,727	(51)
25-29	869	(16)
30-34	582	(11)
35-39	495	(09)
40-44	162	(03)
45+	65	(01)
Paygrade		
E1-E3	2,077	(39)
E4-E6	2,831	(53)
E7-Warrant Officers	273	(05)
O1-O3	174	(03)
O4-O6	23	(<1)
Ship type		
Amphibious	3,442	(64)
Cruisers	602	(11)
Destroyers	863	(16)
Frigates	471	(09)

The frequency of major ICD-9-CM categories associated with these encounters is presented in Table II. Injuries (including conditions due to external factors such as motion sickness), musculoskeletal disorders, and respiratory infections accounted for 60% of recorded sick-call visits. Comparative frequencies by rank are also displayed.

Table II. Distribution of encounters by major ICD-9-CM category and rank.

Major ICD-9-CM categories	Enlisted No.	%	Officers No.	%	Total No.	%
Respiratory system	1,565	30	83	42	1,648	31
Injury & musculoskeletala	1,541	30	39	20	1,580	29
Skin or subcutaneousb	445	9	17	9	462	9
Infectious or parasitic	405	8	13	7	418	8
Digestive system	302	6	9	5	311	6
Health services (V codes)c	241	5	9	5	250	5
Nervous system or sense organs	226	4	12	6	238	4
Genitourinary system	108	2	4	2	112	2
Circulatory system	106	2	3	1	109	2
Mental disorders	79	2	1	<1	80	2
Symptoms, signs, or ill-defined conditions	72	1	3	2	75	1
Endocrine, nutritional, metabolic, or immunity disorder	69	1	2	1	71	1
Neoplasms	16	<1	0	<1	16	<1
Complications of pregnancy or childbirth	5	<1	1	<1	6	<1
Blood or blood-forming organs	1	<1	1	<1	2	<1
TOTAL					5,378	100

[a] Two major ICD-9-CM categories, musculoskeletal conditions and injuries, have been combined. The latter category also includes conditions due to poisoning, violence, and other external causes.

[b] Athlete's foot has been classified here as a skin condition. It is classified as an infectious disease in ICD-9-CM.

[c] Although health services are a subset of ICD-9-CM supplemental classifications, they account for a substantial proportion of encounters and are therefore included as a major ICD-9-CM category.

Health services (ICD-9-CM supplementary classifications, or V codes) accounted for 250 visits. These were primarily for general examinations—check in, check out,

and reenlistment (N = 145), and reproductive services—pregnancy management and testing, family planning, contraception, and sterilization (N = 58).

Performing a more finite diagnostic analysis, we obtained frequencies for 90 ICD-9-CM subcategories. Table III presents the five leading major categorical complaints and the most frequently encountered subcategorical conditions associated with them. Examples of the more common conditions associated with some of these subcategories appear in parentheses.

Table III. Five leading ICD-9-CM categories and their most frequently occurring subcategories.

Respiratory (n=1648)	No.
Acute upper respiratory	1507
Other URIs (sinus congestion, allergies, chronic URI)	85
Pneumonia & influenza	41
Asthma	11
Injuries and Musculoskeletal (n=1580)	
Sprains and strains	571
External causes (motion sickness)	134
Back and neck disorders	116
Superficial injuries	112
Rheumatism (excluding the back)	97
Joint disorders	95
Contusions (intact skin surface)	78
Intercranial injuries	70
Limb wounds	68
Fractures (verified or suspected)	63
Burns	43
Open wounds to head, neck, trunk	43
Skin and subcutaneous tissue (n=462)	
Other (ingrown toenail, cyst, hair problem)	162
Fungal disease of the skin, hair, or nails (athlete's foot)	114
Inflammation (contact dermatitis, eczema)	103
Infection (cellulitis, abcess, carbuncle)	83
Infectious (n=418)	
Viral & Chlamydiae (mixed viral symptoms)	157
Intestinal	132
Fungal (excluding fungal diseases of the skin, hair, & nails)	47
Bacterial, other (strep throat)	44
Digestive (n=311)	
Noninfective enteritis, colitis	219
Esophagus, stomach, duodenum (pain, gastritis, ulcer)	43
Intestinal, peritoneum (constipation, IBS, colon spasms)	20

The 10 most frequently encountered subcategories, irrespective of their major category affiliation, are presented in Table IV, in descending order of frequency. Nine of these subcategories appear in Table III, but the tenth, diseases of the ear and mastoid process, does not because the nervous system/sense organ category to which it belongs, was not one of the five leading categories presented in Table III.

Table IV. Leading ICD-9-CM subcategories.

Minor ICD-9 Categories	No.	%
Acute respiratory infections (460-466)	1507	28
Sprains and strains of joints and adjacent muscles (840-848)	571	11
Noninfective enteritis and colitis (555-558)	219	4
Other diseases of skin and subcutaneous tissue (700-709)	162	3
Effects of external causes (990-995) (primarily motion sickness)	134	2
Intestinal infectious diseases (001-009)	132	2
Diseases of ear and mastoid process (380-389)	127	2
Back and neck disorders (720-724)	116	2
Superficial injuries (910-919)	112	2
Inflammations, other (690-698)	103	2
TOTAL	3183	59

The frequency of the most commonly occurring major categories assigned to each visit by gender indicated rough correspondence for all categories with the exception of genitourinary (GU) disease (Table V.). GU visits involved 6.1% women versus 1.2% men. Also, there was twice the proportion of health services provided (V codes) for woman than for men. This was due largely to reproductive services.

Table 5. Distribution of encounters by leading ICD-9 categories and gender.

	Men		Women	
Major ICD-9 Categories	No.	%	No.	%
Respiratory system	1413	32	235	25
Injury, musculoskeletal	1324	30	256	27
Skin or subcutaneous	393	9	69	7
Infectious or parasitic	337	8	81	9
Digestive system	256	6	55	6
Supplementary factors (V codes)	171	4	79	8
Nervous system or sense organs	192	4	46	5
Genitourinary system	54	1	58	6

More discrete diagnoses (3-5 digit deep ICD-9-CM codes) were examined by gender and again we found comparability in the top 10 conditions affecting women and men with a few exceptions. Motion sickness and urinary tract infections were among those conditions most commonly diagnosed in women, while various sprains and strains were identified more often in men. These results are presented in Table VI.

Table VI. Leading 10 discrete conditions diagnosed in women versus men.

	No.	%	Cum % (total visits)
Women			
Acute URI of multiple or unspecified sites	131	14	14
Motion sickness, sea sickness	70	7	21
Acute sore throat	32	3	25
Noninfectious gastroenteritis, other (diarrhea)	32	3	28
Disorder of urinary tract (UTI)	29	3	31
Acute sinusitis	28	3	34
Family planning advice	24	3	36
General medical examinations	20	2	39
Sprains and strains, other and ill-defined	18	2	41
Viral gastroenteritis	18	2	42
Men			
Acute URI of multiple or unspecified sites	716	16	16
Acute sinusitis	287	6	23
Acute sore throat	157	4	26
Noninfectious gastroenteritis, other (diarrhea)	151	3	30
General medical examinations	125	3	32
Sprains and strains, other and ill-defined	114	3	35
Viral infection, unspecified sites (mixed viral symptoms)	105	2	37
Sprains and strains of ankle and foot	104	2	40
Sprains and strains of back and neck	99	2	42
Viral gastroenteritis	88	2	44

When we examined the ages of women encountered compared with men, we found the women to be comparatively younger (see Table VII).

Table VII. Age distribution of women compared with men.

	Age Group							
	17-19	*20-24*	*25-29*	*30-34*	*35-39*	*40-44*	*45+*	*TOTAL*
Women	119 (13%)	551 (58)	159 (17)	44 (5)	48 (5)	19 (2)	8 (1)	948
Men	359 (8%)	2176 (49)	710 (16)	538 (12)	447 (10)	143 (3)	57 (2)	4,430

When provider dispositions were examined, light/modified duty or no duty was recommended in 12.8% (*n*=686) and 11.5% (*n*=621) of the encounters, respectively. Sixty percent of the 1,307 encounters resulting in either modified/light duty or lost work were caused by three conditions: (1) acute respiratory disease (*n*=306, 23%); (2) intestinal disease, infectious and noninfectious (*n*=250, 19%); and (3) sprains and strains (*n*=253, 18%). We also identified those conditions that were most likely to compromise duty status, even if infrequently encountered. These were dislocations (*n* =11, 64% resulting in lost/modified duty), lower limb wounds (*n*=13, 62%), abdominal hernias (*n*=14, 57%), fracture (*n*=63, .55%), upper limb wounds (*n*=55, 51%), sprains/strains (n = 571, 44%), back and neck disorders (*n*=116, 42%), and joint disorders (*n* =95, 33%).

Dispositions were stratified by gender, age, paygrade, and ship type, and the results are displayed in Table VIII. Providers returned women to full duty more often than men. The older the patient and the higher his/her rank, the less often duty was compromised. Full duty resumption ranged from a high of 79% for those working aboard cruisers to a low of 50% for those aboard frigates.

TABLE VIII. Distribution of disposition status by gender, age, paygrade, and ship type.

	Full Duty	Light/No Duty	
		No.	%
		No.	%
	Gender		
Women		743	(78)
Men		3,122	(70)
	Age		
17-19		314	(66)
20-24		1,888	(69)
25-29		635	(73)
30-34		464	(80)
35-39		383	(77)
40-44		133	(82)
45+		48	(73)
	Paygrade		
E1-E3		1,387	(67)
E4-E6		2,097	(74)
E7-W4		215	(79)
O1-O3		146	(84)
O4-O6		20	(87)
	Ship type		
Frigates		234	(50)
Cruisers		478	(79)
Destroyers		636	(74)
Amphibious Ships		2,517	(73)

	Light/No Duty	
	No.	%
	189	(20)
	1,118	(26)
	142	(29)
	733	(27)
	207	(24)
	91	(16)
	99	(20)
	21	(13)
	14	(23)
	597	(29)
	640	(22)
	43	(16)
	24	(13)
	3	(13)
	190	(40)
	111	(18)
	212	(24)
	794	(23)

Discussion

The five leading major categorical complaints most frequently encountered, in descending order of frequency, were respiratory, injury and musculoskeletal, skin, infectious, and digestive illnesses. These coincide with the four most frequent DNBI categories identified in a recent study of aggregate DNBI incidence reports encompassing 5,385 person-years of data across multiple ship types in a forward deployed fleet. In that study dermatologic, respiratory, work- and training-related injuries, and gastrointestinal and infectious diseases were the primary reasons for patient visits.[17]

However, dermatologic conditions were the number-one DNBI problem reported in these forward-deployed (Indian Ocean/Persian Gulf) crews, while respiratory illnesses most frequently brought sailors to sick bay in our 15-ship southern California data set.

These results are also consistent with the findings of Nice and Hilton, in which injuries/musculoskeletal problems, infectious/parasitic, respiratory, and skin conditions comprised 4 of their 5 leading major categories. The fifth category, health services, was the second leading reason for patient visits. Their aggregate group distributions of illnesses/disorders (48%), health services (25%), and injuries/ musculoskeletal (27%) contrast with our distribution of 66%, 5% and 29%, respectively, indicating that health services may have been under-recorded in this smaller data set.

Examining results in Table III, five of the most frequently encountered conditions in the injury/musculoskeletal category are musculoskeletal in nature (sprains and strains, back disorders, rheumatism, joint disorders, and fractures) and account for 60% (N = 942) of this subset of visits and 18% of all sick-call visits. Musculoskeletal injuries are known to be an important problem in military training and operational populations. It has been observed that injuries involving the lower extremity, neck, and back most often result in lost work days.[6] Balcom and Moore studied musculoskeletal injuries aboard an amphibious ship and found that overuse musculoskeletal injuries occurred most frequently, but that acute musculoskeletal injuries caused the greatest morbidity as measured by lost and modified workdays. Interestingly, there were relatively few acute injuries occurring at sea versus in port, underscoring the risk of off-duty injuries occurring ashore.[5] Kaufman and associates concluded that in the training environment, contributing factors (e.g., physical fitness, training intensity, equipment, and footwear) can be modified to reduce these kinds of injuries. This would require active surveillance and a trial of appropriate interventions in sentinel shipboard military populations to aid in identifying intrinsic and extrinsic risk factors, designing and evaluating the efficacy of prevention strategies, and prioritizing interventions.[18]

Examining Tables V and VI, genitourinary infections, motion sickness, and health services were more often associated with female encounters, while sprains and strains were more often associated with male encounters. Disproportionately greater GU conditions and requests for health services would be expected in a population of young women of child-bearing age, who require more reproductive services (e.g., contraceptive management, Pap smears). More research on motion sickness may be required to more fully understand the gender differences found here and in the Nice and Hilton study, where women were seen 3.73 times more often than men for this condition. As the Navy opens more seagoing billets to women it will be important to determine the significance of this finding. Park et al. found that while women reported greater historical incidence of motion sickness than men, interestingly, there were no significant differences in the severity of motion sickness symptoms reported during a laboratory experiment in which 47 women and men viewed an optokinetic rotating-drum for 16 minutes.[19]

Demographic and Vessel Characteristics

Both sexes studied were younger than in the Navy at large. Encounters involving women under age 25 comprised 71% of the female encounters in this study, while women under age 25 comprise only 50% of women Navy-wide. Similarly, encounters involving men under age 25 comprised 57% of male encounters versus 38% of men Navywide.[20] There are several possible explanations. Sailors assigned to ships tend to be younger than their shore-based counterparts. It is also possible that the older they are, the more both men and women tend to seek medical help off ship. It has been established that a small subset of patients tend to account for the majority of sick-call visits.[21] Since our data set had been stripped of patient identifiers, we were not able to characterize the extent of this phenomena in our data set, but it is possible that this subpopulation might distort the age distribution.

Rank (paygrade) is a useful demographic variable and is used here as a surrogate for socioeconomic status, given that it incorporates age, education, salary level, living conditions, type of work, and concomitant health-related exposures. In the small sample of encounters involving officers (n =197), results indicate officers sought

medical attention proportionately less often for injuries than enlisted members (20% vs. 30%) but more often for respiratory conditions (42% vs. 30%). Also, the higher his/her paygrade, the less often duty was compromised (see Table VIII). This is consistent with Helmkamp and Bone's hospitalization study demonstrating an inverse relationship between risk of injury and seniority (represented by paygrade), but in contrast to findings by Krentz et al. in which experience and seniority were not significantly related to a change in duty status. Helmkamp and Bone theorize that inherent differences in the degree of environmental risk factors impacting higher versus lower paid personnel probably account for this phenomenon. More senior and higher paid members tend to hold duties with less hands-on, labor-intensive, hazardous tasks and environmental exposures (e.g., operating heavy equipment or mopping up oil) compared with younger, unrated personnel.[24]

Race was not analyzed because data on ethnicity were incomplete. This may not be an important study limitation since race is not a particularly useful demographic in this well-integrated population. All recruits who complete training and remain in service receive the same pay for similar jobs and have the same access to care.

Gender-related differences in sick-call utilization has been examined in previous research studies.[4,7,9,10] Although we were not able to calculate and compare utilization rates between men and women, we were able to discern some gender-specific trends, previously outlined. The proportion of visits for genitourinary and reproductive services appears low compared with the body of literature and may indicate that for certain aspects of their care, women aboard ships studied in this sample sought treatment off ship. No information is available to explain this disparity, however the tendency to seek care off ship is plausible given the sensitive nature of reproductive, genitourinary, and family planning-related needs; sexually transmitted disease; and inherent confidentiality issues. This may also occur if women do not have confidence in their provider,[22] if modesty is an issue (lack of privacy screens), or if the facility is perceived to be inadequate (lack of up-to-date equipment and supplies).

In exploring the impact of ship type on illness incidence, Blood and Griffith found that rates were lower for the larger versus smaller ships. They also discovered higher rates of communicable diseases aboard the small vessels and conjecture that a restricted environment may facilitate transmission.[23] Helmkamp and Bone found that personnel aboard destroyers, replenishment ships, and conventional carriers had a significantly increased risk of being hospitalized when compared with their shore-based counterparts.[24] Although the sample size in the present study was too small to yield information on the relationship between ship type and sick-call patterns, an expanded analysis of SAMS data involving a greater number of ships representing a variety of platforms may shed more light on this question.

Study Limitations

A minority of crew members conceivably account for the majority of medical encounters examined in this study, so age, gender, ship type, and paygrade frequencies and distributions across diagnostic categories will disproportionately reflect the characteristics of this subpopulation. Although shipboard medical encounter data to meet surveillance and preventive medicine objectives are now available and accessible using SAMS, these data represent an as yet unknown proportion of the total number of encounters taking place aboard ship. Furthermore, diagnostic information was incomplete and not always accurate. As a result, under-reporting and misclassification problems exist. As a result, our findings should be considered tentative until additional analyses with new, more complete and accurate data can be performed.

Not all of the encounters taking place aboard ship were entered in SAMS, creating a "volume" problem. Use of SAMS to document medical encounters is mandated by Fleet directive but has not yet been fully implemented.[25] Volume most likely varies by individual provider and by ship type as well. Several factors may account for this variation. The DOS-based version of SAMS, from which these data were drawn, was not easy to use and training was not universally available. Of the various types of medical providers, only independent duty corpsmen (IDCs) have been required to not only learn but also demonstrate competency in using SAMS, as part of their formal IDC training.

Not all the records received contained diagnostic codes. Because ICD-9-CM coding or useful SOAP note information with which to abstract diagnostic codes was not electronically recorded for all visits, as many as 19% of the encounter records supplied by participating ships could not be used. When provided, diagnostic information might not have been accurate in all cases. With the exception of IDCs, Navy medical providers have not been trained in ICD-9-CM coding. Providers often lack definitive information provided by ancillary services, such as laboratory and x-ray results, for a more precise diagnosis, especially aboard the smaller ships. If encounter records for the more difficult to diagnose illnesses are missing ICD-9-CM codes and therefore cannot be included in the analysis, such conditions will be disproportionately under-represented.

Various Navy entities have been addressing these problems. Investigators at NHRC and the Navy Environmental Preventive Medicine Unit (NEPMU) No. 5 have compiled a list of the top 100 ICD-9-CM codes typically diagnosed on ships and have provided this list along with education to corpsmen aboard San Diego home-ported ships. Recent initiatives with "preventive medicine partnerships" between NEPMUs and their local Fleet concentrations are under way to facilitate improved management of a wide variety of preventive medicine programs. These offer promise in improving the accuracy and completeness of notifiable disease reporting and electronic disease surveillance. In addition, SAMS has been upgraded to a Windows-based system that encourages more electronic documentation and helps providers choose, with point-and-click features, appropriate diagnostic codes based on SOAP note symptoms. Ships are also now receiving quarterly coding and volume "performance" reports. Finally, NHRC and the medical staff of Commander, Naval Surface Force Pacific have agreed to provide specific guidance to promote ICD-9-CM coding throughout the Fleet.

Under-reporting limits the potential of calculating incidence rates and can compromise the internal validity and generalizability of analysis results. Until the extent of data entry deficiencies are known and are resolved, the calculation of incidence rates should be postponed. Denominator (population) data presumably will be accurate, but the numerator data (case counts) may be deceptively low. Rates

could therefore underestimate incidence and the magnitude of this error will vary, compromising comparisons and trending. As an example, on Ship A, 60 influenza cases are treated, 40 are recorded and 30 of these include diagnoses, resulting in 50% under-reporting of influenza. On Ship B, of 60 influenza cases treated, 55 are recorded, and 50 of these include diagnoses, resulting in 17% underreporting. As this example illustrates, accurate numerator data are essential. In the meantime, case counts and proportions provide valuable information and should still be reported. Once more complete recording of encounters into SAMS has been achieved, crude and adjusted rates can be calculated and reported. An examination of illness and injury patterns by individual ship and by ship type will then be possible, allowing ships to compare their own rates and trends with comparable ships.

Potential bias.

Variation in the diagnostic classification of cases may have distorted the results. Cases are probably not defined uniformly by provider levels and by providers within a level—corpsmen may diagnose differently than physicians. None are trained in coding except IDCs. Additionally, platforms and ships within a platform vary due to disparities in the diagnostic equipment and supplies on board. For example, a small ship may diagnose as a probable fracture a case that a carrier, with better xray equipment, may diagnose as a sprain/strain, having ruled out the fracture. It is important to remember that a large number of patient encounters in operational units, particularly when underway, never receive the definitive laboratory or diagnostic testing to establish a definitive diagnosis.

Several additional nonmedical factors potentially influence the frequency of encounters, including prevailing attitudes, a ship's culture and ethics, morale, and the commander's policies and practices. At times these influences may create bias in the data and can distort results. Counts are also influenced by (1) gender, (2) by what proportion of the crew seeks help off ship (e.g., for convenience, lack of respect for provider aboard ship, to maintain anonymity—on small ships especially the crew works and plays alongside the providers who diagnose and treat them), (3) ship

location—pier-side or deployed, visiting higher risk ports (smaller ships visit ports more often), and (4) the number of hours that sick call is held each day.

Influences that inhibit crew members from seeking help might include a sense of duty (e.g., being needed on the job, particularly on smaller ships where one person's absence has a greater impact), job satisfaction, high shipboard morale, a culture where seeking help is discouraged by supervisors or would elicit the disapproval/ disrespect of peers, and incentives to stay well (e.g., staying healthy in preparation for a port visit). Influences that lower the threshold for seeking medical attention might include poor morale, a culture where seeking help and/or time off from work is encouraged by peers, and a higher incidence of certain personality characteristics that bring individuals to the sick bay. Melton reported that low morbidity findings can result from underutilization occurring when the crew holds an unfavorable opinion of the medical provider aboard ship and seeks treatment ashore, from poor recordkeeping and morbidity reporting practices, and from the unknown nature of visits that are not reported by diagnosis.26

Benefits of Continued SAMS-Supported Surveillance

Current Navy policy is concerned with maintaining a fit and healthy force.[27] Ongoing medical and environmental surveillance is an important component of this mission. Some of the more important surveillance objectives include (1) monitoring the health of shipboard personnel, particularly before, during, and after deployment (2) detecting emerging health problems to facilitate the implementation of early intervention and control strategies; (3) measuring the impact of health promotion, intervention, prevention and control strategies; (4) identifying risk factors and health hazards affecting crew health and safety; (5) helping optimize resource and manpower allocations; and (6) improving cost effectiveness. As the DoD moves toward "cradle to grave" electronic disease surveillance, electronic reporting systems such as SAMS will be critical to capturing medical information from the Fleet and Marines, particularly during routine deployments.

Individual ships can also benefit. Continued in-depth analysis of injuries and illnesses can help shipboard providers better understand the morbidity patterns

unique to their own ship so they can deliver more effective care. This knowledge enables them to identify problems, make changes, implement programs, and optimize resources. Reliable baseline and post-intervention data are not routinely available for analysis to assess the effect of prevention and intervention programs. Cost savings and cost avoidance therefore cannot be systematically measured. Providing shipboard illness and injury rates will provide these vital before and after measures.

Medical staffing, training, and supply allocation could be improved if those medical conditions routinely encountered on a given ship were better identified. Planners could then tailor assignments to the needs of the ship to optimize care and readiness. Pertinent questions include: Is a female corpsman recommended? A female general medical officer? A physician's assistant? A physical therapist? Most ships do not currently require each of these personnel, so providing a ship-specific configuration should conserve resources while improving care. It would also be useful to know if the type of medical staffing aboard ship influences diagnostic practices and dispositions. Studies have now documented that in general, dermatologic complaints, respiratory illness, diarrhea, and injuries of various etiologies remain the largest contributors to morbidity in operational units.[8,9,17]

The present study demonstrates the potential for improved SAMS-supported surveillance to promote shipboard health and readiness. Shipboard medical encounter data that meet surveillance objectives are becoming available and accessible as SAMS usage improves in both the quality and completeness of encounter information recorded. Preventive medicine personnel, commanders, medical educators, and medical planners should find such data, and the surveillance information they generate, invaluable in efforts to improve the health of Navy and Marine Corps personnel.

Acknowledgments

The authors thank Rex Sanderson for his diligence in obtaining the SAMS data used in this study; Sue Hilton for her statistical programming assistance; CDRs Sandra A. Almeida, MC, USNR and Debra Carroll, MC, USNR for their efforts in working with the SAMS data project and improving coding information for shipboard medical personnel, and Dr. Eric Gunderson for providing historical information relevant to this research.

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1. Report Date (DD MM YY)	2. Report Type	3. DATES COVERED (from - to)
Jul 02	Final	

4. TITLE AND SUBTITLE A Descriptive Analysis of Medical Encounters Aboard 15 Navy Surface Ships Home-ported in San Diego

6. AUTHORS
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7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
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8. SPONSORING/MONITORING AGENCY NAMES(S) AND ADDRESS(ES)
Chief, Bureau of Medicine and Surgery
Code M2
2300 E St NW
Washington DC 20372-5300

5a. Contract Number:
5b. Grant Number:
5c. Program Element: 0604771N
5d. Project Number:
5e. Task Number:
5f. Work Unit Number: 60001
5g. IRB Protocol Number:

8. PERFORMING ORGANIZATION REPORT NUMBER
Report No. 02-32

10. Sponsor/Monitor's Acronyms(s)
BuMed

11. Sponsor/Monitor's Report Number(s)

12 DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release; distribution unlimited.

13. SUPPLEMENTARY NOTES

14. ABSTRACT (maximum 200 words)

There has been no mechanism for comprehensively monitoring shipboard illnesses and injuries in over a decade. Electronic medical encounter records from the Shipboard Non-Tactical ADP Program (SNAP) Automated Medical System (SAMS) installed aboard individual vessels are now available and were acquired for this descriptive study of sick-call visits aboard 15 San Diego, California, home-ported Navy ships. An extensive examination of ICD-9-CM diagnostic and demographic frequencies is presented. Of the 5,378 encounters examined, the most frequent major categorical complaints were respiratory (31%), injury and musculoskeletal (29%), dermatologic (9%), and infectious or parasitic illnesses (8%). Frequency of diagnosis was largely unrelated to gender, although men were more apt to be seen for sprains and strains and women for genitourinary conditions and reproductive services. Of 1,307 en-counters that resulted in either modified/light duty or lost work, 60% were caused by upper respiratory infections (23%), intestinal disease (19%), and sprains/strains (18%). This is the first in-depth analysis of SAMS data obtained from a diverse sample of surface ships, and it demonstrates the substantial surveillance capability now available to continuously monitor shipboard health and readiness. Such surveillance, if monitored actively, should enhance our ability to intervene early, identify modifiable risks, assess prevention and control efforts, and improve the allocation of limited resources.

14. **Subject Terms**
shipboard illnesses and injuries

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGE	18a. NAME OF RESPONSIBLE PERSON
a. REPORT	b.ABSTRACT	C. THIS PAGE			Commanding Officer
UNCL	UNCL	UNCL	UNCL	23	18b. TELEPHONE NUMBER (INCLUDING AREA CODE) COMM/DSN: (619) 553-8429