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SEVERITY OF BATTLE INJURIES OCCURRING ABOARD U. S. NAVAL WARSHIPS

E. D Gauker

C. G. Blood

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NAVAL HEALTH RESEARCH CENTER
P.O. BOX 85122
SAN DIEGO, CALIFORNIA 92186-5122

NAVAL MEDICAL RESEARCH AND DEVELOPMENT COMMAND
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Eleanor D. Gauker
Christopher G. Blood

Medical Decisions Support Department
Naval Health Research Center
P.O. Box 85122
San Diego, CA 92186-5122

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SUMMARY

Problem

Operational planning for forces afloat is critical because ships may be incapacitated during attack by either structural damage or loss of crew function due to battle wounds. Data describing wound severity, measured by days on sick call, combined with previous information on numbers and types of afloat battle wounds, will allow more specific medical and manpower planning.

Objective

The present study examines the number of sick days caused by battle wounds among forces afloat during World War II and analyzes the effect of various ship and weapon types on wound severity.

Approach

Information on date, type of injury, and weapon of attack was extracted from Medical Officer Reports, After Action Reports, or Deck Logs corresponding to shipboard attacks. The date of final disposition was obtained from NAVMED-F forms which were matched to each case. Frequency distributions and analyses of variance and covariance were used to analyze mean sick days across weapons and ship types involved in the attack.

Results

The mean number of sick days across all conditions was 53.14. Seventeen percent of shipboard wounded returned to duty on the day of injury, and 12 percent spent from one to three days on the sick list. The remaining 61 percent of wounded spent four or more days on the sick list. Both weapon and ship type were significant factors in determining the severity of wounds, even after the effect of injury type was removed. Bombs caused longer-lasting injuries and showed greater variability across ship types than other weapon systems.

Conclusions

Because the operational effectiveness of attacked warships is affected by loss of crew function, an important finding is that approximately 30 percent of injuries incurred are of a nature which allows a return to duty in three days or less. Planning of naval operations will also benefit from knowledge of anticipated wound severity as well as information specifying numbers and types of battle casualties.

SEVERITY OF BATTLE INJURIES OCCURRING
ABOARD U.S. NAVY WARSHIPS

INTRODUCTION

Supplies, equipment, and personnel are allocated according to projected requirements for peacetime as well as the additional support needed in the event of armed conflict. Contingency planning for forces afloat, however, poses a unique problem. Because ships operate as self-contained platforms, they can be incapacitated in an attack either by structural damage or by reductions in crew size related to casualties. While the development of various models has made it possible to predict structural damage, most of these models lack accurate assessments of the number of casualties and degree of crew impairment which can be expected when ships are attacked by different weapon systems.[1] This information is needed not only for medical resource planning purposes, but also by manpower logisticians concerned with the operational effectiveness of a ship after it is attacked.

A recent study[2] enumerated the killed-in-action (KIA), wounded-in-action (WIA), and types of injuries incurred aboard different classes of U.S. warships in attacks by various weapon systems during World War II. Both weapon type and ship type were shown to be significant factors in the numbers of KIA and WIA. Attacks by multiple weapons caused the highest mean casualties per incident, followed by torpedoes, bombs, kamikaze, mines, and gunfire. The mean number of KIA per incident was especially high for multiple weapon and torpedo attacks, leading to high overall casualty rates. Among ship types, carriers and escort carriers had significantly more wounded per incident than destroyers, destroyer escorts, battleships, and light cruisers. In addition, weapon type had a significant effect on some injury types. Kamikaze incidents produced more burns when compared with gunfire, while mine incidents yielded more strains, sprains and dislocations than bomb, kamikaze or gunfire attacks.

Predictive models of a ship's operating effectiveness would be enhanced by incorporating casualty data. Further, in addition to projections of the numbers of WIA and KIA, information about the severity of potential afloat battle injuries as measured by the length of sick list stays could be used to determine initial manpower requirements and the cross-training that would be needed to continue operations in case of attack.[3]

This study will examine data detailing the degree of impairment among the wounded. From the previous study of U.S. warships during World War II, it is known that different weapons cause different injury types. It is also known that different injuries, such as fractures, are more disabling and require a longer recuperative period than injuries such as contusions. The first objective of this study, therefore, is to determine the length of sick list stays for different injury types.

The previous study found that weapon and ship type were significant factors in number of injuries per incident. This study, as its second objective, will determine whether weapon and ship type affect the overall length of sick list stays. Further analyses will ascertain whether specific weapons cause injuries of all types to be more serious, or whether they cause certain types of injuries which are more severe. Additional examination of ship types will determine if the crews of some ship types are more susceptible to serious injuries, and/or whether they are more vulnerable to specific types of injuries.

METHOD

Two historical sources, the Summary of War Damage[4] and the United States Naval Chronology, World War II[5] were examined to obtain a list of World War II warships which were attacked and could have sustained casualties. Data collected from these two sources include the ship name, hull number, date of incident, location, weapon involved in the attack, and whether the ship was sunk or damaged. Because the most specific information was limited to battleships, carriers, cruisers, and destroyers, the current investigation is restricted to these categories of warships.

The Medical Officer Reports and After Action Reports maintained at the Operational Archives division of the Navy

Historical Center in Washington, D.C. were examined and BUMED codes[6] were extracted for casualty incidents corresponding to those found in the War Damage Summary and Naval Chronology. When the medical information on these incidents was not available from the Historical Center, the deck logs of these ships were reviewed and the relevant information extracted. Deck logs are housed at the National Archives in Washington, D.C. Crew complements of the sunk/damaged ships were collected from the muster rolls housed at the National Archives. Medical data collected from these three sources include the service number of the casualty, BUMED injury code, and the date of injury. Additionally, NAVMED-F forms (F-cards) were used by the Navy during World War II to document sick list admissions and were available for 1944 and 1945. Cross-matching the available F-cards, which are housed at the Navy Medical Archives in St. Louis, with previously extracted casualty data, yielded a database of injuries with disposition dates.[6]

The injury codes were collapsed into the following categories: Fractures, Burns, Penetrating Wounds, Concussions, Contusions/ Abrasions, Traumatic Amputations, Sprains/Strains/ Dislocations, Asphyxiation, Non-fatal Immersions, Multiple Wounds and Other/Unspecified. To assess weapon effects, only those incidents involving a single weapon were used. They are: Bombs, Gunfire, Kamikaze, Mines, and Torpedoes. Ships were limited to eight classifications of surface combatants: Battleships (BB), Heavy Cruisers (CA), Light Cruisers (CL), Aircraft Carriers (CV), Escort Carriers (CVE), Light Carriers (CVL), Destroyers (DD), and Destroyer Escorts (DE).

The current study measures wound severity by the number of sick days caused by injuries. This measure of impairment yields insight into crew losses as well as days of medical care needed.

The frequency count and mean number of sick days were determined for each injury type, and the percentage of casualties for number of days on sick list by injury type was calculated. Frequencies of wounds were cross-tabulated by weapon and ship type, and the mean number of sick days was computed for these variables.

Analysis of variance (ANOVA) was performed to determine whether weapon and ship type were significant. In addition, analysis of covariance removed the effect of injury types to further test the significance of weapon and ship effects.

RESULTS

There were 4529 battle injuries recorded which included beginning and ending dates for sick list stays. Table 1 shows the distribution of injury types in the sample, with frequency counts

TABLE 1. DISTRIBUTION OF INJURY TYPES

INJURY TYPE	N	%	MEAN SICKDAYS
PENETRATING INJURIES	1776	39.2	45.9
BURNS	1180	26.1	47.9
MULTIPLE INJURIES	517	11.4	82.0
FRACTURES	308	6.8	131.7
CONTUSIONS/ABRASIONS	254	5.6	11.2
CONCUSSIONS	202	4.5	34.6
OTHER	124	2.7	31.2
STRAINS/SPRAINS/DISLOCATIONS	88	1.9	13.1
ASPHYXIATIONS	48	1.1	8.1
TRAUMATIC AMPUTATIONS	25	0.6	169.1
NON-FATAL IMMERSIONS	7	0.2	1.6
TOTAL	4529	100.0	53.1

and mean sick days for each category. Penetrating wounds (39.2%), burns (26.1%) and multiple wounds (11.4%) were the most frequent injury types. Fractures, contusions, concussions, strains, asphyxiations, amputations, or other injuries occurred in 23.3 percent of cases.

Traumatic amputations, fractures, and multiple injuries had the highest mean sick days, while non-fatal immersions, asphyxiations, contusions and strains had the lowest. Overall, 17.2 percent of shipboard injuries were treated and returned to duty on the day of injury, and an additional 12 percent of wounded personnel spent from one to three days on the sick list. The remaining 70.8 percent spent four days or longer on the sick list. A breakdown of these findings is displayed in Table 2.

TABLE 2. PERCENTAGE OF CASUALTIES BY DAYS ON SICK LIST AND INJURY TYPE; WWII SHIPS 1944-45

INJURY TYPE	NUMBER OF DAYS ON SICK LIST										TOTAL %
	0	1-3	4-7	8-14	15-21	22-28	29-60	61-90	91-186	187+	
AMPUTATIONS	--	--	4.0	12.0	4.0	4.0	12.0	4.0	12.0	48.0	100.0
ASPHYXIATIONS	14.6	41.7	18.8	10.4	--	2.1	12.5	--	--	--	100.0
BURNS	16.9	8.3	6.3	12.2	9.1	8.1	15.4	5.3	12.0	6.4	100.0
CONCUSSIONS	10.9	6.4	7.9	6.9	5.4	40.6	9.4	2.0	6.9	3.5	100.0
CONTUSIONS	31.5	32.7	10.2	5.1	7.9	5.5	4.7	--	1.2	1.2	100.0
NON-FATAL IMMERSION	28.6	57.1	14.3	--	--	--	--	--	--	--	100.0
FRACTURES	0.6	2.3	3.6	9.1	8.1	4.5	15.9	4.2	18.2	33.4	100.0
PENETRATING WOUNDS	21.7	12.2	8.0	8.1	6.6	6.4	15.0	4.5	10.6	6.8	100.0
SPRAINS/STRAINS	42.0	21.6	5.7	14.8	1.1	6.8	2.3	2.3	1.1	2.3	100.0
MULTIPLE	5.0	11.4	7.0	8.5	7.7	5.6	17.8	5.4	14.3	17.2	100.0
OTHER	15.3	19.4	8.9	17.7	9.7	2.4	14.5	1.6	6.5	4.0	100.0
TOTAL	17.2	12.0	7.3	9.5	7.8	7.9	14.4	4.2	10.8	9.2	100.0

Table 3 cross-tabulates the number of injuries by weapon and ship type. Kamikaze attacks caused 68 percent of the casualties in this sample, while gunfire, bombs, torpedoes and mines caused the remaining 32 percent. The largest proportion of casualties, 41.5 percent, occurred on destroyers, followed by battleships and aircraft carriers, each with 14.7 percent, and light cruisers with 10.7 percent. Heavy cruisers, escort carriers, light carriers and destroyer escorts accounted for a total of 18.4 percent.

TABLE 3. DISTRIBUTION OF AFLOAT BATTLE INJURIES BY WEAPON AND SHIP TYPE

	BOMB	GUNFIRE	KAMIKAZE	MINE	TORPEDO	ROW TOTAL
BATTLESHIP	19	168	480	--	1	668
HEAVY CRUISER	18	52	23	--	--	93
LIGHT CRUISER	200	2	211	--	56	469
AIRCRAFT CARRIER	122	21	517	--	5	665
ESCORT CARRIER	3	73	212	--	--	288
LIGHT CARRIER	10	18	81	--	--	109
DESTROYER	80	282	1380	82	56	1880
DESTROYER ESCORT	3	16	177	--	161	357
COLUMN TOTAL	455	632	3081	82	279	4529

A 5x8 factorial ANOVA performed on mean sick days indicated that both weapon ($F_{4,4499}$=14.546, $p<.001$) and ship type ($F_{7,4499}$=12.381, $p<.001$) were significant. Bombs, with a mean of 78.94 sick days per injury, caused longer-lasting injuries than gunfire ($\bar{X}$=56.40), kamikaze ($\bar{X}$=49.63), mines ($\bar{X}$=47.60) and torpedoes ($\bar{X}$=43.69). Among ship types, injuries sustained aboard light carriers (CVL) were less severe ($\bar{X}$=27.08) compared to injuries aboard destroyers ($\bar{X}$=44.39), escort carriers ($\bar{X}$=51.64), battleships ($\bar{X}$=53.89), destroyer escorts ($\bar{X}$=54.45), aircraft carriers ($\bar{X}$=55.79), heavy cruisers ($\bar{X}$=75.30) and light cruisers ($\bar{X}$=84.74). The interaction between weapon and ship type was also significant ($F_{18,4499}$=5.408, $p<.001$). Table 4 is a display of mean sick days by weapon and ship type combined. It can be seen that the sick days associated with

TABLE 4. MEAN SICK DAYS BY WEAPON AND SHIP TYPE; WWII SHIPS 1944-45

SHIP TYPE	NUMBER OF INJURIES	MEAN SICK DAYS	S.D.
	BOMBS		
BATTLESHIP	19	72.32	99.55
HEAVY CRUISER	18	17.72	49.47
LIGHT CRUISER	200	111.08	122.53
AIRCRAFT CARRIER	122	53.35	82.52
ESCORT CARRIER	3	358.67	109.21
LIGHT CARRIER	10	83.90	63.49
DESTROYER	80	43.95	74.70
DESTROYER ESCORT	3	22.67	19.66
TOTAL FOR BOMBS	455	78.94	107.34
	GUNFIRE		
BATTLESHIP	168	66.08	97.60
HEAVY CRUISER	52	84.21	90.12
LIGHT CRUISER	2	94.50	68.59
AIRCRAFT CARRIER	21	54.28	72.82
ESCORT CARRIER	73	58.03	78.24
LIGHT CARRIER	18	26.06	49.75
DESTROYER	282	47.54	82.95
DESTROYER ESCORT	16	45.06	52.16
TOTAL FOR GUNFIRE	632	56.40	86.06
	KAMIKAZE		
BATTLESHIP	480	49.01	73.25
HEAVY CRUISER	23	100.22	72.69
LIGHT CRUISER	211	74.72	112.19
AIRCRAFT CARRIER	517	56.80	80.01
ESCORT CARRIER	212	45.09	83.83
LIGHT CARRIER	81	20.30	30.36
DESTROYER	1380	43.63	68.49
DESTROYER ESCORT	177	60.23	72.68
TOTAL FOR KAMIKAZE	3081	46.67	76.34
	MINES		
DESTROYER	82	47.60	101.74
TOTAL FOR MINES	82	47.60	101.74
	TORPEDOES		
BATTLESHIP	1	1.00	0.00
LIGHT CRUISER	56	28.05	58.44
AIRCRAFT CARRIER	5	17.00	22.97
DESTROYER	56	45.45	62.37
DESTROYER ESCORT	161	49.61	81.20
TOTAL FOR TORPEDOES	279	43.69	73.04
TOTAL-ALL WEAPONS	4529	53.14	82.14

bombs are more variable across ship types than either gunfire or kamikaze, which display considerably less variability.

To determine whether these effects were significant over and above the effect for injury type, an analysis of covariance was performed on mean sick days, using a set of binary variables to control for injury type. Type of injury, as expected, was significantly related to longer sick list stays ($F_{11,4488}$=62.797, p<.001); however, weapon ($F_{11,4488}$=7.416, p<.001), ship type ($F_{7,4488}$=9.023, p<.001), and their interaction ($F_{18,4488}$=4.471, p<.001) all contributed significantly to length of sick list stay even while controlling for the variance associated with injury type.

DISCUSSION

Contingency planning for forces afloat differs from that of ground forces. Ships are crewed platforms which require sufficient personnel to maintain operations in the event of an attack; therefore, a warship can be incapacitated by loss of crew function as well as by the physical damage sustained by its structure. A ship attacked and damaged at sea, however, can often regenerate its fighting capacity over a period of time through organized damage control.

Because crew casualty assessment methodology must consider this time factor, accurate projections of weapon effects should include the ability of the crew to control damages, conduct battle repair and regain fighting ability[1]. In this context, it is meaningful to know the length of incapacitation which might be expected from injuries sustained by crewmembers in various attack scenarios. An important finding of this study indicated that although the mean number of sick days per injury was 53.14, approximately twelve percent of personnel sustaining combat injuries spent only one to three days on the sick list and seventeen percent of casualties returned to duty on the same day they were injured. These crewmembers, although wounded, could in all likelihood continue to defend the ship and/or perform damage control. The remaining seventy-one percent, who spent from four days to over six months on the sick list, would require evacuation and/or replacement and would be unavailable for damage control.

In the current study, the greatest percentage of injury types were penetrating wounds, burns, and multiple wounds. Both weapon and ship type were shown to be significant factors in the severity of injuries incurred. Further, injuries caused by bomb attacks tended to require considerably more recuperative time than those caused by other weapons, and crew members injured aboard light carriers and destroyers spent less time on the sick list than those injured aboard other types of warships.

Certain types of injuries such as fractures and traumatic amputations, obviously, are more severe in terms of number of days of recovery needed than injuries such as contusions or non-fatal immersions. This study demonstrated that both weapon and ship effects were significant determinants of wound severity even after the variance associated with different injury types was removed.

The importance of accurate needs projections has become increasingly evident as military downsizing necessitates reductions in budgets and personnel in the wake of recent world events.[7] In the Navy's 1992 Posture Statement[8], former Secretary H. Lawrence Garrett stated that the Navy's present goal is to maintain the strongest navy in the world while streamlining costs. This will be accomplished, said Garrett, through detailed planning for possible future scenarios.

The analysis of historical data in this study is valuable because it provides useful information about the nature of manpower loss caused by injuries during enemy attacks. Data describing the severity of afloat battle injuries along with previously reported information on the numbers and types of casualties sustained in various shipboard attacks will assist in projecting the manpower and medical resource requirements for future naval operations. Combining this information with current specifications for ship structures and weapon systems will allow for reliable projections of shipboard battle casualties and the impact of those casualties on operational effectiveness.

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P. O. Box 85122
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To measure wound severity, the number of sick days related to battle injuries sustained by forces afloat during World War II was determined. The mean number of sick days per injury was 53.14. Seventeen percent of wounded crew members were treated and returned to duty on the same day, while an additional 12 percent spent one to three days on the sick list. Analyses of variance and covariance were performed on number of sick days across weapon and ship type. Both weapon and ship type, along with their interaction, were significant in determining the severity of wounds while controlling for the variance associated with injury type. This information, in combination with data on changes to ship structures and weapon systems will allow for reliable projections of shipboard battle casualties and their effect on operational effectiveness.

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