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USAARL REPORT NO. 71-18

CRASH INJURY ECONOMICS: INJURY AND DEATH COSTS IN ARMY UH-1 ACCIDENTS IN FISCAL YEAR 1969

By

CPT Armand E. Zilioli, M.D.

and

MAJ Jay C. Bisgard, M.D.

December 1971

U. S. ARMY AEROMEDICAL RESEARCH LABORATORY

Fort Rucker, Alabama

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13. ABSTRACT

Injury and fatality costs of Army aircraft accidents have never been determined. During fiscal year 69, there was a total of 546 major and minor noncombat aircraft accidents involving UH-1 type helicopters. This report presents an economic study of the 160 individuals with major injuries and 227 fatalities which occurred in 129 of these accidents. Minor injuries were not considered in this study. Personnel costs of aircraft accidents were evaluated using hospitalization and convalescence times and costs, pay costs, replacement costs, funeral costs, death benefits and Veterans Administration and Social Security Administration benefits. These costs were computed using the least expensive method. Human costs, such as pain, suffering, deformity, or the loss of earning power are factors which are real costs but which cannot be determined.

The total treatment time for the 160 injured individuals was 19,097 days. When considered on the basis of a 246 day work year, the total treatment time equaled 77.6 work years.

The average personnel costs of an aircraft accident ranged from $38,227 for a survivable accident to $408,757 for a nonsurvivable accident. The average hardware cost of an aircraft accident was $220,772. The monetary cost of injuries and fatalities can often considerably exceed the sum required to replace an aircraft.

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FOREWORD

This report is the second in a series of studies being conducted on the economics of Army aircraft accident morbidity and mortality by the Bioengineering and Evaluation Division.

Captain Armand E. Zilioli was Chief, Human Dynamics Branch, Bioengineering and Evaluation Division during the data collection phase of this study. Currently, he is a resident in Orthopedic Surgery, University of Miami, School of Medicine.

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CRASH INJURY ECONOMICS: INJURY AND DEATH COSTS IN ARMY UH-1 ACCIDENTS IN FISCAL YEAR 1969

INTRODUCTION

Investigation reports of all Army aircraft accidents are sent to the United States Army Agency for Aviation Safety (USAAAVS), where accident statistics, including aircraft costs, are compiled and studied. Although records of accident injuries and fatalities are compiled and maintained, the monetary costs of passenger and crewmember trauma have never been completely determined.[1] [2] [3] [4] Human costs are much more difficult to assess than are hardware costs. It is nonetheless necessary to determine personnel costs as accurately as possible, because the dollar is used as a common denominator between people and objects in the justification of costs of improved safety equipment and is the fundamental factor in design and management decisions.

This report presents cost estimates based upon a study of the deaths and major injuries which occurred in noncombat accidents of UH-1 type Army helicopters during FY 69. The study included both crewmembers and passengers. All aircraft involved in accidents have crews, but not all have passengers; crewmembers have, therefore, the greatest accident risk exposure. Primary crewmembers (aircraft commander and pilot) benefit from shoulder restraints and more crashworthy seats. All crewmembers are protected by helmets and fire protective clothing unavailable to passengers. The types and severity of the injuries and therefore the costs of injuries might be expected to differ between crewmembers and passengers. For this reason the Results and Discussion section of this report is divided into parts; Part A is devoted to crewmembers, Part B to passengers and Part C to a summary.

DEFINITIONS AND BACKGROUND

Certain terms used in this report have significant meanings which may not be apparent to the reader. These definitions provide necessary background information.[5] [6]

A. Accident Types:

(1) A minor aircraft accident is one which results

in damage to the aircraft which will require more than 100, but less than 500 manhours to repair.

(2) A major aircraft accident is one which results in destruction of the aircraft, or damage which will require at least 500 manhours to repair.

B. Crash Survivability:

(1) A survivable accident is one in which the crash forces do not exceed the limits of human tolerance and the inhabitable area of the aircraft remains intact; i.e., structural collapse is not sufficient to impinge upon or crush vital areas of persons seated in a normal position.

(2) A partially survivable accident is one in which the crash forces do not exceed the limits of human tolerance, but only a portion of the inhabitable area of the aircraft remains intact. Fatal injuries or occupancy are not criteria of crash survivability determination. For example, if the front seat of a tandem seat aircraft is demolished, but the structure surrounding the rear seat is intact, the accident is classified as partially survivable even if the rear seat occupant was fatally injured. The accident would still be partially survivable even if the rear seat was unoccupied.

(3) A nonsurvivable accident is one in which the impact forces exceed human tolerance and/or all inhabitable areas collapse or disintegrate at impact to such a degree that all occupants would sustain crushing injuries of vital body areas.

C. Injury Classification:

(1) A minor injury is one which results in hospitalization or sick in quarters status for at least one day, but not more than four days and is not one of the injuries defined as major.

(2) A major injury is one which results in five or more days of hospitalization or any of the following without regard to hospitalization: unconsciousness due to head trauma; fracture, open or closed, of any bone other than closed fractures of the phalanges or the nasal bones; traumatic dislocation of any joint (excluding phalanges) or internal derangement of the knee; injury of the internal organs; moderate to

severe lacerations which cause extensive hemorrhage or which require extensive surgical repair; any third degree burn and second degree burns involving more than 5% of the body surface.

NOTE: Aircraft accidents are defined by the damage to the aircraft, not by the injuries of the occupants. There may be no injuries in a major accident, or there may be deaths in a minor accident. In this study, however, only one major injury resulted from a minor accident; a man sustained an arm fracture which required outpatient treatment.

MATERIALS AND METHODS

The Data Processing Division of USAAAVS provided a computer printout listing the 546 major and minor UH-1 noncombat accidents which occurred during FY 69. The USAAAVS investigation report for each accident listed was searched for major or fatal injuries of U. S. servicemen. Minor injuries were not included because, when compared with major injuries and deaths, they can be expected to account for a much smaller economic loss. In every case where a major injury or fatality occurred, the occupants of the aircraft were noted by name, rank, service number, seat position [aircraft commander (A.C.), pilot, passenger, etc.], first treatment facility and injury type. In addition, accident location, estimation of aircraft hardware cost and accident survivability were recorded.

Information concerning major injuries was obtained from medical summaries and Clinical Record Cover Sheets (DA Form 8-275-3). These were obtained from the facilities recorded as having initially treated the accident victims. When patients were transferred to other hospitals, requests for records were also sent to those hospitals. A determination of the exact nature of the injury, evacuation route, hospitalization time, convalescence time and disposition (duty, retirement, etc.) was established for each patient.

Transit time during medical evacuation was considered to be inpatient hospitalization time. Hospital costs per inpatient day were made available by The Office of The Surgeon General of the Army (TSG).[7] Medical evacuation costs were provided by the Military Airlift Command of the U. S. Air Force.[8]

A list of all the injured personnel was sent to the Retirement Branch of the Adjutant General's Office[9] and to the

Veterans Administration (VA)[10] for assistance in identifying those individuals who were retired for medical reasons and those who had applied for disability benefits. The amounts of the disability benefits were also requested.

Information regarding the return of aviators to flight status following disqualifying injuries was furnished by TSG.[11] The names of aviators not returned to flying status were obtained from the Office of Personnel Operations.[12] Replacement costs of aviators not returned to flying status were considered to be accident costs. These costs were taken from USAARL Report Number 71-17.[4] Replacement costs of disabled enlisted men and nonaviator officers were not available.

Pay (base pay and aircrew flight pay only) received by individuals while absent from duty during periods of hospitalization and convalescence was also considered to be an accident cost. Pay costs were taken from FY 69 pay tables.[13]

Finally, for each injured individual a data processing card was key punched with the following information: USAAAVS accident number, seat position, accident survivability, injury type, pay grade, Social Security Administration number, hospitalization time, convalescence time, evacuation cost, hospital cost, pay received, replacement costs and amount of retirement pay or VA disability benefits.

The aviator fatalities were studied in a similar manner. A list of all of the fatalities was sent to: (1) the Army Finance Center[14] for the amounts of Army Death Benefits; (2) the VA[10] for the amount of Death and Indemnity Compensation (DIC) paid to the next of kin; (3) the Social Security Administration (SSA)[15] for the amount of benefits paid to the next of kin. Funeral costs were taken from Department of the Army (DA) Pamphlet 608-4.[16] Aviator replacement costs were taken from USAARL Report Number 71-17.[4] For each aviator a data processing card was keypunched with the following information: USAAAVS accident number, seat position, accident survivability, medical cause of death, pay grade, Social Security Administration number, amount of Army Death Benefits, amount of VA benefits, and replacement cost.

Passenger and enlisted crewmember fatality costs were taken from DA Circular 385-16.[1] These costs are, at best, approximations based upon Army wide averages. They include all of the same cost sources considered for aviator fatalities. These figures were used because there are no separate

replacement costs available for passengers and/or enlisted crewmembers. Data processing cards were keypunched with the same basic information listed for aviators. The only exception was the use of the single cost figure.

For each accident studied, a data card was punched with the USAAAVS accident number, accident survivability, aircraft hardware cost, numbers of crewmembers and passengers aboard each aircraft, accident morbidity or mortality and the number of aircraft involved in the accident.

A statistical program was written for computer data analysis.

RESULTS AND DISCUSSION

A. Crewmembers

1. Injury Types and Costs:

During FY 69, there was a total of 546 major and minor noncombat aircraft accidents involving Army UH-1 type helicopters; 126 crewmembers sustained major injuries and 160 crewmembers were killed in 121 of these accidents.

A large majority of the accidents occurred outside the continental United States (OCONUS). Injured personnel were evacuated to the nearest medical facility for emergency treatment. If the injuries necessitated further treatment, patients were transported to larger hospitals in Japan or Europe, or directly to a CONUS Class II hospital, such as Walter Reed, or to a Class I hospital, such as Fort Devens Army Hospital. Following hospital treatment, patients were sent on convalescent leave, returned to full or limited duty, or retired for medical disability.

Table I shows the major injury types in relation to crew duty positions. For the purposes of this study, when two or more major injuries were sustained by one individual, the most significant injury was considered to be the one which required the longest treatment time. Back injuries were the most common injury type for each crew position. The majority of the injuries were lumbar vertebral compression fractures.

TABLE I

INJURY TYPES IN RELATION TO CREW DUTY POSITIONS

INJURY TYPE	A.C.* (RT. SEAT)	PILOT** (L. SEAT)	STUDENT PILOT OBSERVER	CREW CHIEF	DOOR GUNNER	TOTALS	PERCENT
HEAD	6	8	1	5	5	25	20
NECK	-	2	-	1	-	3	2
BACK	13	15	-	7	9	44	35
CHEST	-	-	-	-	1	1	1
ABDOMEN	-	-	-	-	2	2	2
UPPER EXTREM.	3	5	-	6	1	15	12
LOWER EXTREM.	8	6	-	6	8	28	22
BURNS	4	1	-	2	1	8	6
TOTAL	34 (124)	37 (119)	1 (4)	27 (110)	27 (102)	126 (459)	100%

(Numbers in parentheses indicate the populations at risk.)

* Includes two student pilots.
** Includes four instructor pilots.

The risk of a particular type of injury is very difficult to define due to the unique combination of factors which culminate in any given crash injury. It is certain, however, that crash forces were severe enough to exceed the capabilities of crewmember protective equipment and/or aircraft crashworthiness in the accidents which resulted in major or fatal injuries. The population at risk was considered to be the total number of aircrewmen aboard the aircraft involved.* It was assumed, for purposes of this determination, that each aircrew position was at equal risk. The populations at risk so derived appear in parentheses beside the totals in Table I.

Table II indicates the average times of hospitalization and convalescence required for the various injury types and their average costs.

TABLE II

CREWMEMBER AVERAGE TREATMENT TIMES AND COSTS

INJURY TYPE	N	AVG DAYS HOSP TIME	AVG DAYS CONV TIME	AVG TOT TREATMT TIME	AVG COST FY 69 $	AVG COST FY 70 $
HEAD	14	57	22	79	2,210	2,690
NECK	2	107	21	128	3,777	4,542
BACK	27	45	21	66	1,676	2,044
CHEST	0	0	0	0	0	0
ABDOMEN	0	0	0	0	0	0
UPPER EXTREM.	6	112	90	202	4,220	5,154
LOWER EXTREM.	17	106	101	207	3,337	4,667
BURNS	7	93	37	130	3,605	4,433
TOTAL	73					

N = Number of hospital records available for calculation of averages.

* The apparent discrepancy between numbers of aircraft and accidents is due to the fact that there were two accidents involving two aircraft and one involving three aircraft.

Although hospital records were requested for each of the 126 injured crewmembers, only 73 were available for the calculation of average times of hospitalization and convalescence.

Average actual treatment costs were calculated by multiplying the average number of hospital days by the FY 69 average inpatient costs per day of CONUS hospitals. The average cost per day in a Class II facility was $39 per day, while in a Class I facility it was $31 per day. The actual treatment costs are extremely conservative and in some cases distorted for the following reasons:* (1) they do not reflect the higher cost of care outside CONUS, especially in a combat zone where many patients received their first care; (2) they do not reflect the costs of outpatient visits during convalescence; (3) the inpatient costs during FY 69 were unrealistically low due to a shortage of health care personnel in Army hospitals combined with a greatly increased inpatient census.

No adjustment can be made for the combat zone costs and outpatient costs, but a more realistic cost figure for inpatient care can be determined. The personnel and patient load discrepancies were largely corrected during FY 70. Consequently, Table II contains a column of FY 70 costs which were derived using the costs of $48 per day in a Class II facility and $36 per day in a Class I facility. These costs give some idea of what hospitalization would have cost had the discrepancy between patient load and hospital personnel not been so great.

Total treatment times and costs for the different injury types appear in Table III. These figures are based on the averages in Table II.

---

*By Comparison:

The FY 69 overall Army hospital cost per inpatient day was $31.00, excluding Army physician care costs of $5.00 per day. A comparable FY 69 figure for civilian hospitalization was $76.00 per day.[17]

TABLE III

CREWMEMBER TOTAL TREATMENT TIMES AND COSTS

INJURY TYPE	#INJ	TOT DAYS HOSP TIME	TOT DAYS CONV TIME	TOT DAYS TREATMT TIME	TOT COST FY 69 $	TOT COST FY 70 $
HEAD	25	1,429	548	1,977	55,249	67,255
NECK	3	321	62	383	11,331	13,626
BACK	44	1,973	931	2,904	73,740	89,936
CHEST	1	0	0	0	0	0
ABDOMEN	2	0	0	0	0	0
UPPER EXTREM.	15	1,680	1,350	3,030	63,300	77,310
LOWER EXTREM.	28	2,974	2,834	5,808	108,447	130,669
BURNS	8	743	299	1,042	28,843	35,465
TOTALS	126	9,120	6,024	15,144	340,910	414,261

Evacuation costs were calculated using USAF rates for transportation of injured personnel.[8] Representative charges include $55 from Saigon, RVN to Yokota, Japan; $101 from Japan to Travis AFB, California and $133 from Japan to Kelly AFB, Texas or Andrews AFB, Maryland.

Base pay and flight pay received by crewmembers while absent from duty during periods of hospitalization and convalescence were considered to be accident costs. The figures were calculated from FY 69 pay tables.[13]

In order to keep the cost estimate errors on the conservative side, it was assumed that personnel returned to flying duties on the date of discharge to duty, unless there was definite information to the contrary. Table IV shows the

various injury types and the dispositions of aviators whose injuries disqualified them for further flight duties. With the exception of the aviator retained on flying status as a result of waiver recommended by The Surgeon General, physically disqualified aviators and student aviators were lost to Army aviation. These men were either suspended from flying status and given ground duty assignments or were retired from the Army for medical reasons.

TABLE IV

DISQUALIFIED AVIATOR DISPOSITIONS IN RELATION TO INJURY TYPES

INJURY TYPE	# AVIATORS DISQUAL.	# AVIATORS WAIVERED	# SUSPENDED FROM FLYING	# MEDICALLY RETIRED
HEAD	3	1	2	
UPPER EXTREM.	2		2	
LOWER EXTREM.	2		1	1
BURNS	1	—	—	1
TOTALS	8	1	5	2

Table V presents the ranks and replacement costs of the aviators who were lost to Army aviation because of their injuries. Replacement costs were taken from USAARL Report Number 71-17.[4]

TABLE V

REPLACEMENT COSTS OF INJURED AVIATORS

RANK	REPLACEMENT COST PER AVIATOR $	# AVIATORS LOST	TOTAL COST OF REPLACEMENT $
WOC	38,035	1	38,035
2 LT	38,035*	1	38,035
WO 1	144,076	5	720,380
TOTALS		7	796,450

* This officer was a student pilot. His training cost certainly exceeded that of a WOC, but because no exact training cost was available the WOC cost was used.

Individuals who have been discharged from the military services, either as a direct result of their injuries or upon completion of obligated service, may apply to the VA for medical disability compensation. As of April 1971, 18 crewmembers had applied for VA disability benefits. Through December 1971, the total amount paid for these claims was $96,600. The predicted amount to be paid on a yearly basis starting in 1972 and running indefinitely will be $49,400 for currently authorized benefits. This sum will increase if additional individuals apply for benefits.

Table VI shows the various available costs which contribute to the total crewmember injury cost estimate. It should be pointed out, however, that other costs are unavailable, such as the administration costs involved with medical retirements, replacement costs of disqualified crew chiefs and door gunners, etc. Therefore, the costs presented in Table VI are extremely conservative and represent only identifiable and tangible costs for the cases studied.

TABLE VI

CREWMEMBER INJURY COSTS

TREATMENT COSTS FY 69	$ 340,910
EVACUATION COSTS	12,966
PAY COSTS (BASE PAY & FLIGHT PAY ONLY)	188,105
REPLACEMENT COSTS (7 AVIATORS ONLY)	796,450
VA COSTS (THROUGH DEC 1971)	96,600
RETIREMENT COSTS (THROUGH DEC 1971)	7,900
TOTAL	$1,442,931

2. Fatality Types and Costs (Crewmembers)

Table VII presents the numbers of crewmember fatalities in relation to crew duty and accident survivability. Accident

survivability is included for two reasons. First, the crewmember fatalities which occurred in survivable accidents may be considered to have been due to injuries which could possibly have been prevented by improved personal protective equipment or improved aircraft crashworthy design. Second, the nonsurvivable accident fatality figures indicate the need for continued effort to improve aircraft crashworthiness and to enhance survivability through crash resistant fuel systems, helicopter escape systems, energy attenuating seats and better fuselage design.

TABLE VII

FATALITIES IN RELATION TO CREW DUTY AND ACCIDENT SURVIVABILITY

CREW DUTY	NUMBER OF FATALITIES			
	SURVIVABLE	PART SURVIVABLE	NONSURVIVABLE	TOTALS
A.C.*	2 (71)	11 (22)	22 (31)	42 (124)
PILOT**	3 (71)	11 (21)	25 (27)	41 (119)
STU PILOT OBSERVER	0 (0)	1 (2)	2 (2)	3 (4)
CREW CHIEF	3 (64)	7 (17)	29 (29)	39 (110)
GUNNER	4 (65)	8 (14)	23 (23)	35 (102)
TOTALS	14 (271)	38 (76)	108 (112)	160 (459)

(Numbers in parentheses indicate populations at risk.)
* Includes 7 student pilots
** Includes 5 instructor pilots

Table VIII shows the number of fatalities in relation to medical causes of death and accident survivability. Head injuries are presented separately because it may be possible to examine the efficacy of the protective helmet using these figures. A separate study of the costs of head injuries and

the association between helmet loss and head injury is in progress. The crash force category includes all other fatal trauma caused by impact. The burns and drowning categories represent post crash complications. The subject of deaths in survivable Army aircraft accidents from FY 65 through FY 69 is covered in detail in a paper by Berner and Sand.[18]

TABLE VIII

FATALITIES IN RELATION TO CAUSE OF DEATH AND ACCIDENT SURVIVABILITY

CAUSE OF DEATH	NUMBER OF FATALITIES			
	SURVIVABLE	PART SURVIVABLE	NONSURVIVABLE	TOTALS
HEAD INJURY	5	5*	3	13
CRASH FORCES	3	15	85	103
BURNS	5	15	15	35
DROWNING	1	3	5	9
TOTALS	14	38	108	160

*One pilot sustained a depressed skull fracture and 50% body burns. It was assumed that the head injury occurred first and hindered escape from the fire. The other occupant of the aircraft was able to escape from the fire.

Table IX lists the crewmember fatalities in relation to rank. Officers, Warrant Officers (WO's) and Chief Warrant Officers (CWO's) were rated aviators and Warrant Officer Candidates (WOC's) were student pilots. Enlisted men were crew chiefs and door gunners.

TABLE IX

CREWMEMBER FATALITIES IN RELATION TO RANK

RANK	PAY GRADE	NUMBER OF FATALITIES	PER CENT OF TOTAL
MAJOR	O-4	3	
CAPTAIN	O-3	6	
1 LT	O-2	13	
CWO 2	W-2	10	
WO 1	W-1	47	
WOC	E-5	7	
	Total Officers	86	53%
	Enlisted men	74	46%
	TOTAL CREWMEMBERS	160	100%

The costs of replacing the lost aviators are shown in Table X.

TABLE X

AVIATOR REPLACEMENT COSTS

RANK	REPLACEMENT COST PER AVIATOR	NO. AVIATORS	TOTAL COST
MAJOR	353,167	3	$ 1,059,501
CAPTAIN	181,893	6	1,091,358
1 LT	128,004	13	1,664,052
CWO 2	137,375	10	1,373,750
WO 1	144, 076	47	6,771,572
WOC	38,035	7	266,245
	TOTALS	86	$12,226,478

In order to assess the total available costs of aviator fatalities the following additional costs were considered:

(1) Funeral costs up to $1,200 per aviator were paid by the Army.

(2) Death benefits equal to six months base pay up to a maximum of $3,000 were paid by the Army to the next of kin. (Other costs, e.g., the salary of the survivor assistance officer and moving costs of the deceased aviator's household goods are not considered.)

(3) VA Death and Indemnity Compensation was being paid to the next of kin of 41 aviator fatalities as of April 1971. The amount paid is based upon the pay grade of the deceased. Through December 1971, $212,000 had been paid to the next of kin. A projected yearly amount to be paid indefinitely beginning in January 1972 is $93,000. If the same assumptions which were used to predict the VA and SSA costs in USAARL Report 71-17[4] are used to calculate the yearly VA costs for the aviator fatalities in the present study, it would be

expected that 32 claims would result in a cost of $91,472. Comparing these figures with the actual figures tends to support the contention that the assumptions would lead to conservative estimates.

(4) SSA benefits were being paid to the next of kin of 25 aviator fatalities as of April 1971. The amount paid is based on the individual's Social Security account credits prior to death. Through December 1971, $154,541 has been paid to the next of kin. A projected yearly amount to be paid indefinitely beginning in January 1972 is $77,976. Based on the aforementioned assumptions, there should eventually be 32 claims amounting to a yearly total of $207,284. Theoretically, there should be the same number (41) of VA and SSA claims; but as of April 1971 this was not the case. This may merely indicate that the processing time for VA claims was less than that required for SSA claims. Consequently, the assumptions used in USSARL Report No. 71-17[4] can neither be validated nor invalidated by the SSA data presented in this report.

The total available aviator fatality cost calculations are shown in Table XI.

TABLE XI

TOTAL AVAILABLE COSTS OF AVIATOR FATALITIES

REPLACEMENT COSTS (Table X)	$12,226,478
FUNERAL COSTS (86 @ $1,200 ea)	103,200
ARMY DEATH BENEFITS	245,915
VA BENEFITS (Through December 1971)	212,200
SSA BENEFITS (Through December 1971)	154,541
TOTAL	$12,942,334

The VA and SSA costs will be continuing at their present rate, unless increased by Congress, until the widows remarry and/or their children reach age 22.

The enlisted crewmember fatality costs were taken from DA Circular 385-16.[1] It must be reiterated that these figures are only approximations based on Army wide cost averages. Table XII presents the calculated cost of crewmember fatalities.

TABLE XII

TOTAL AVAILABLE COST OF CREWMEMBER FATALITIES

AVIATOR COSTS (Table XI)	$12,942,334
ENLISTED CREWMEMBER COSTS (74 Enlisted Men @ $42,400 per man)	3,137,600
TOTAL	$16,079,934

B. Passengers

1. Injury Types and Costs:

During FY 69, there were 546 UH-1 accidents reported to USAAAVS; 34 passengers sustained major injuries and 67 passengers were killed in 40 of these accidents. Table XIII presents the distribution of injury types. Back injuries were again the most common type of injury. The epidemiology of back injuries is influenced by a number of variables, including, but not limited to, the restraint system and the impact energy absorbing qualities of the seat. Passengers and enlisted crewmembers share the same type of restraint and the same type of seat. Aircraft commanders and pilots have an entirely different restraint system and a different type of seat. For this reason the per cent figures for back injuries in Tables I and XIII are not comparable.

TABLE XIII

PASSENGER INJURIES BY TYPE

INJURY TYPE	# PASSENGERS INJURED	PER CENT
HEAD	5	15
NECK	3	9
BACK	9	26
CHEST	1	3
ABDOMEN	2	6
UPPER EXTREM.	4	12
LOWER EXTREM.	7	21
BURNS	3	9
TOTALS	34 (142)*	100%

* Number in parentheses indicates population at risk.

Table XIV indicates the average times of hospitalization and convalescence required for the various injury types and their average costs. The method used to calculate the costs in Table II was also used for Table XIV.

TABLE XIV

PASSENGER AVERAGE TREATMENT TIMES AND COSTS

INJURY TYPE	N	AVG DAYS HOSP TIME	AVG DAYS CONV TIME	AVG TOT TREATMT TIME	AVG COST FY 69 $	AVG COST FY 70 $
HEAD	1	14	0	14	546	672
NECK	1	92	10	102	3,588	4,416
BACK	5	77	47	124	4,041	4,966
CHEST	0	0	0	0	0	0
ABDOMEN	1	59	0	59	2,301	2,832
UPPER EXTREM.	3	71	26	97	2,647	3,228
LOWER EXTREM.	2	58	116	174	2,098	2,538
BURNS	3	217	29	246	8,476	10,432
TOTAL	16					

Total treatment times and costs for the different injury types appear in Table XV. These figures are based on the average in Table XIV.

TABLE XV

PASSENGER TOTAL TREATMENT TIMES AND COSTS

INJURY TYPE	#INJ	TOT DAYS HOSP TIME	TOT DAYS CONV TIME	TOT DAYS TREATMT TIME	TOT COST FY 69 $	TOT COST FY 70 $
HEAD	5	70	0	70	2,730	3,360
NECK	3	276	30	306	10,764	13,248
BACK	9	692	424	1,116	36,370	44,692
CHEST	1	0	0	0	0	0
ABDOMEN	2	118	0	118	4,602	5,664
UPPER EXTREM.	4	283	103	386	10,587	12,912
LOWER EXTREM.	7	406	811	1,217	14,686	17,766
BURNS	3	652	88	740	25,428	31,926
TOTALS	34	2,497	1,456	3,953	105,167	128,938

As of April 1971, 12 passengers had applied for VA disability benefits. Through December 1971, the total amount paid for these claims was $29,300. The predicted amount to be paid on a yearly basis starting in 1972 and running indefinitely will be $16,500 for currently authorized benefits.

Passenger injury costs are summarized in Table XVI.

TABLE XVI

PASSENGER INJURY COSTS

TREATMENT COSTS FY 69	$128,938
EVACUATION COSTS	3,389
PAY COSTS (BASE PAY ONLY)	40,538
REPLACEMENT COSTS	Unavailable
VA COSTS (THRU DEC 1971)	29,300
RETIREMENT COSTS (THRU DEC 1971)	0
TOTAL	$202,165

2. Fatality Types and Costs (Passengers)

Table XVII shows the number of fatalities in relation to medical causes of death and accident survivability.

TABLE XVII

FATALITIES IN RELATION TO CAUSE OF DEATH AND ACCIDENT SURVIVABILITY

CAUSE OF DEATH	NUMBER OF FATALITIES SURVIVABLE	PART SURVIVABLE	NONSURVIVABLE	TOTALS
HEAD INJURY	4	3	0	7
CRASH FORCES	3	8	24	35
BURNS	5	15	2	22
DROWNING	1	0	2	3
TOTALS	13 (65)*	26 (43)	28 (34)	67 (142)

* Numbers in parentheses indicate the populations at risk.

Using DA Circular 385-16,[1] the estimated total cost of passenger fatalities was $2,840,800 (67 fatalities @ $42,400 per fatality).

C. Summary

A total of 129 of the 546 major and minor UH-1 accidents which occurred during FY 69 resulted in major or fatal injuries of crewmembers and/or passengers. Table XVIII presents the hardware costs of the UH-1 aircraft involved in those accidents.

TABLE XVIII

HARDWARE COSTS OF FY 69 UH-1 ACCIDENTS STUDIED

Cost of 80 UH-1's in 78 survivable accidents	$16,726,900
Cost of 22 UH-1's in 22 part. survivable accidents	5,243,600
Cost of 31 UH-1's in 29 nonsurvivable accidents	7,392,200
TOTAL	$29,362, 700
Average hardware cost of a survivable accident	$214,447
Average hardware cost of a part. survivable accident	$238,345
Average hardware cost of a nonsurvivable accident	$254,903

Table XIX presents the minimum personnel costs of the FY 69 UH-1 accidents.

TABLE XIX

PERSONNEL COSTS OF FY 69 UH-1 ACCIDENTS

Cost of 72 injured aviators (includes student pilots)	$1,120,221	
Cost 54 injured enlisted crewmembers	322,710	
Cost 34 injured passengers	202,165	
Subtotal		$1,645,096
Cost of 86 aviator fatalities (includes student pilots)	$12,942,334	
Cost of 74 enlisted crewmembers fatalities	3,137,600	
Cost of 67 passenger fatalities	2,840,800	
Subtotal		$18,920,734
TOTAL PERSONNEL COST ESTIMATE	$20,565,830	
Average cost of an injured aviator	$ 15,559	
Average cost of an injured enlisted crewmember	5,976	
Average cost of an injured passenger	5,946	
Average cost of an aviator fatality	150,492	
Average cost of an enlisted crewmember fatality	42,400	
Average cost of a passenger fatality	$ 42,400	

Table XX shows the number of injuries and fatalities in relation to accident survivability.

TABLE XX

INJURIES AND DEATHS IN RELATION TO ACCIDENT SURVIVABILITY

	ACCIDENT TYPE			
PERSONNEL	SURVIVABLE	PART. SURVIVABLE	NONSURVIVABLE	TOTALS
AVIATORS:*	(142)	(45)	(60)	(247)
No. Injured	57	13	2	72
No. Killed	7	23	56	86
ENLISTED CREWMEMBERS:	(129)	(31)	(52)	(212)
No. Injured	42	12	0	54
No. Killed	7	15	52	74
PASSENGERS:	(65)	(43)	(34)	(142)
No. Injured	20	10	4	34
No. Killed	13	26	28	67

(Numbers in parentheses indicate populations at risk.)
*Includes student pilots.

The magnitude of the personnel costs may be more clearly demonstrated by calculating average costs based on figures contained in Tables XVIII, XIX and XX. For example, using the injury and fatality figures for aviators and survivable accidents:

57 injuries ÷ 78 accidents =
0.73 injuries/acc X $ 15,559/injury = $11,358/acc

7 fatalities ÷ 78 accidents =
0.08 fatalities/acc X $150,492/fatality = $12,039/acc

AVIATOR PERSONNEL COST PER SURVIVABLE ACCIDENT = $23,397

If similar calculations are performed for the other categories of personnel and accidents, the results shown in Figure 1 are obtained.

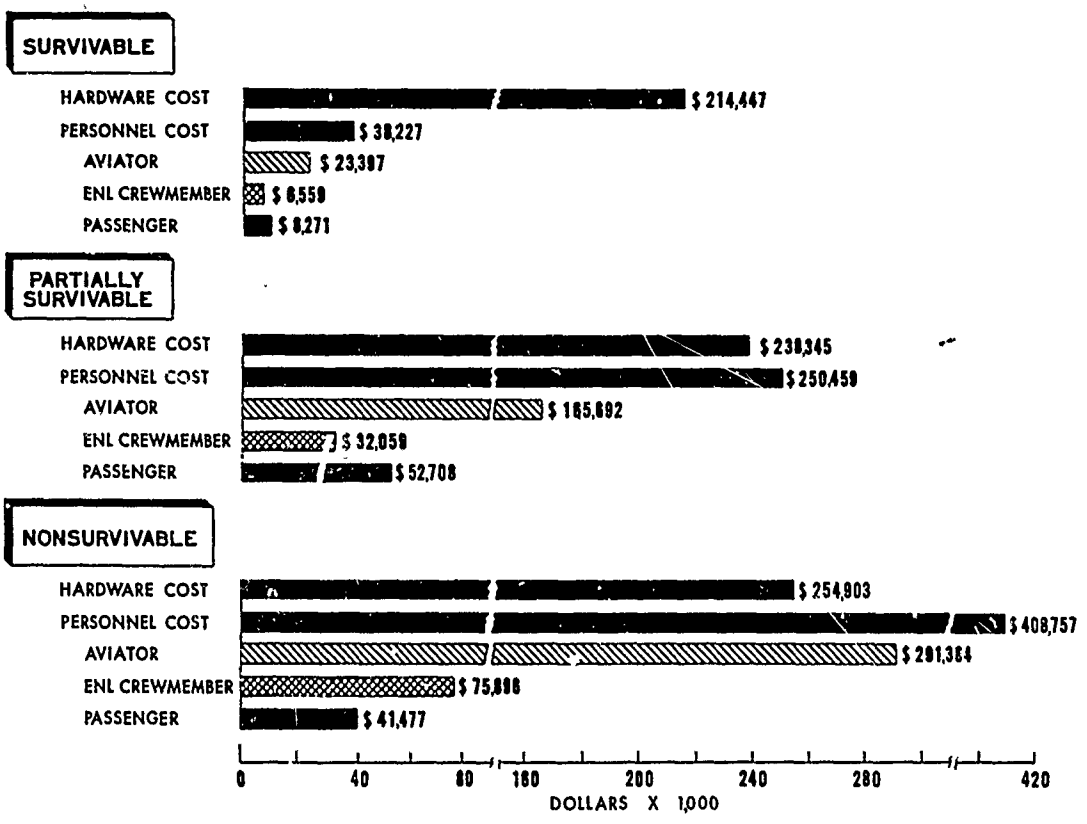

FIGURE 1

AVERAGE HARDWARE AND PERSONNEL COSTS

While there was a large hardware economic loss in Army UH-1 accidents during FY 69, the minimum personnel costs of a nonsurvivable accident were almost twice the hardware cost!

Since the costs presented were computed by the least expensive method using only identifiable and available costs, the actual personnel costs are undoubtedly greater than those described in this study. Many of the other cost factors associated with FY 69 UH-1 accidents can be measured and would have been included if the figures had only been available. Table XXI lists some of these cost factors. Neither the human suffering resulting from an accident, nor the loss of the all important experience factor can be measured monetarily. Money cannot recompense the psychological trauma of an amputation or the grief of the loss of a husband or father.

TABLE XXI

COST FACTORS NOT INCLUDED

Costs of search and rescue or recovery operations, such as "Flatiron"
Crewmember and passenger minor injury costs
Costs of visits made by convalescent patients to outpatient clinics
Salaries of crewmembers discharged to duty but temporarily unable to fly
Replacement costs of medically retired passengers and enlisted crewmembers
Payment to next of kin for up to 60 days of deceased aviator's accrued leave
Administrative costs of processing VA claims
Administrative costs of processing SSA claims
Administrative costs of retirement of disabled personnel
Salaries of survival assistance officers
Costs of transporting dependents of deceased personnel
Costs of transporting household goods of deceased personnel

With the rapidly rising trend in replacement training costs and medical treatment costs, the personnel costs of future accidents will certainly become an even larger portion of overall accident costs.

CONCLUSION

A study of the personnel costs of injuries and fatalities which occurred in Army UH-1 accidents during FY 69 has been presented. There were 129 accidents involving 160 individuals with major injuries and 227 fatalities. The total treatment time for the 160 injured individuals was 19,097 days. When considered on the basis of a 246 day work year, the total treatment time equaled 77.6 work years! The total hardware cost of these accidents was $29,362,700 compared with an estimated total personnel cost of $20,565,830. This personnel cost is not implied to represent the actual personnel cost because the costs presented were calculated using the least expensive method.

Although it may seem callous to place dollar values on human life and well being, it is nonetheless a fact that decisions which influence safety, aircraft design, personnel management, etc., are often based upon economic factors. The application of current bioengineering technology and crashworthy aircraft systems design concepts would certainly lead to a reduction of fatality rates in Army aircraft accidents. Likewise, many injuries would be less severe or prevented completely. Such improvements as better personal protective equipment, better seat and airframe design to attenuate crash forces and crashworthy fuel cells to decrease the occurrence of post crash fires can be shown to be cost effective through the use of human cost figures. It is therefore essential that the costs of preventable injuries and deaths be considered in cost effectiveness studies used to make decisions which will influence the safety and welfare of the occupants of Army aircraft.

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