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EDGEWOOD ARSENAL
TECHNICAL REPORT

EATR 4359

HEAD TRAUMA: ANALYSIS OF 120 CASUALTIES IN VIETNAM FROM JULY 1967 TO JANUARY 1968

by

Ian Sunshine, MAJ, MC
Hernan A. Campana, LTC, MC
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March 1970

DEPARTMENT OF THE ARMY
EDGEWOOD ARSENAL
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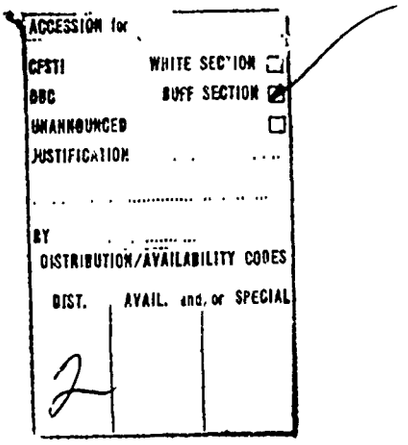

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FOREWORD

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DIGEST

With the purpose of assisting in the development of models for the study of head injury, 120 consecutive case histories of men who sustained head wounds were selected for analysis from the files of the Wound Data and Munitions Effectiveness Team at Edgewood Arsenal. The sample consists of 60 men who died and 60 who survived. These casualties were incurred by combat units of the US Army in the Vietnam campaign, during the period of July 1967 to January 1968.

It was concluded that when the brain is penetrated by a missile in combat, the prognosis is poor. Only 31% of our sample with penetrating injuries (32 cases) survived this type of injury. The prognosis of multiple lobe injuries is very poor. In our sample of fatalities, 21 of 60 men (35%) sustained this type of injury. This was the largest category of injuries to the central nervous system in the fatalities. Frontal lobe damage was observed in 50% of the survivors with open head wounds. This corresponds with reports in the literature regarding the relatively less severe prognosis of frontal lobe injury. Conversely, injuries of the parietal area accounted for the largest number of deaths in single lobe injuries. The data suggest that the helmet offers more protection against fragments than against bullets and may retard a bullet sufficiently to convert a potentially perforating wound into a penetrating one.

CONTENTS

HEAD TRAUMA: ANALYSIS OF 120 CASUALTIES IN VIETNAM FROM JULY 1967 TO JANUARY 1968

I. INTRODUCTION.

This report has been prepared to assist interested agencies in the study of head injury. Review of the literature on acute craniocerebral injuries based on World War II and Korean casualties indicates the seriousness of penetrating head wounds. Preliminary studies based on Vietnam KIA* and DOW** cases show that head wounds are second only to thoracic wounds[1] in lethality and should be the subject of further study.

The present report is an analysis of 120 casualties with acute head injuries caused by bullets and fragmenting munitions. The wounds were incurred by members of the US Army in the Vietnam campaign from July 1967 through January 1968 inclusive. Sixty consecutive KIA and DOW cases with autopsy findings are correlated with 60 consecutive WIA† cases. All men had either penetrating or perforating head wounds. Significant parameters analyzed in each case include wound distribution, wound-tract data, and the relationship of wounds to the weapon that caused the injuries. Other data such as surgery performed, time interval to evacuation, and associated injuries are included.

The material for the review was obtained from the files of the Wound Data and Munitions Effectiveness Team (WDMET) at Edgewood Arsenal. The organization of the team and the methods of data collection have been described in a previous study.[1]

II. MATERIAL AND METHODS.

In this report, the terms penetrating and perforating are used as follows. A penetrating wound is one in which the missile is lodged in the brain or the cranial cavity. A perforating wound is one in which the missile went through the skull and brain, and exited through the skull.

The categories of skeletal and central nervous system (CNS) injuries have been subclassified for ease of analysis. For example, vault fractures of the skull are not grouped with avulsion of the skull and with multiple fractures of the vault because of the different prognoses for the separate categories.

The wound-tract length or depth-of-penetration measurements reflect the total length of the wound tract from the entrance wound to the missile, or to the exit wound in perforating-wound cases.

The fact that 11 men in the DOW and 11 in the WIA category had skull fractures is coincidental. Superficial wounds of the face involving only the skin are not included. Wounds of the eyes are included because of the role of the skull in the skeletal composition of the orbit.

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*Killed in hostile action, died within 30 minutes.

**Died of wounds, survived at least 30 minutes and may have received treatment.

†Wounded in action, wounded and survived.

III. ANALYSIS.

To categorize the head wounds in this sample, we adopted a modification of the classification of Caveness,[2] which has the advantage of incorporating both functional and anatomical criteria, and which basically corresponds to the classification of Harvey Cushing[3] (1918). In general, the head injuries are divided into two main groups: closed head injuries, without dural penetration, and open head injuries, with dural laceration. Closed head injuries are divided into three categories. Category 1 injuries are of no neurological significance. There is no unconsciousness, although the patient may be slightly confused. Category 2 includes concussions, with loss of consciousness up to 12 hours and minimal transient neurological signs. Category 3 injuries are those that reveal overt evidence of underlying brain injury upon surgery and transient neurological deficit. Patients in category 3 may be unconscious up to or beyond 12 hours. Open head injuries are divided into three categories also. Category 4 injuries show no neurological deficit, though dural laceration is present; category 5, neurological deficit, with or without concussion; and category 6, profound dural and brain penetration with ventricular involvement, prolonged coma, hemorrhage, and other complications. These categories include injuries caused by fragments of bone acting as secondary missiles.[4] In this classification, more prognostic significance is given to dural laceration than to the type of skull fracture suffered. In addition, the cases in which the dura mater was lacerated by secondary bone missiles are included among the open head injuries, even if the primary missile did not penetrate the brain. In our series, 70 casualties (58%) had open head injuries. Forty-nine of these 70%) were KIA; 11 (15.75%) were DOW; and 10 (14.3%) were WIA. Fifty cases of the total sample (42%) had closed head injuries and were in the WIA category. Only one casualty (0.9%) had a skull fracture without laceration of the dura mater. Forty-nine (41%) were WIA cases with wounds that did not cause skull fracture (tables I and II). (All tables are in the appendix.)

The distribution among KIA's, DOW's and WIA's of wounds perforating the head and penetrating the brain is shown in (table III). In the combined KIA and DOW group, 27 casualties (45%) had perforating head wounds and 22 (37%) had penetrating wounds and only 10 (16%) had penetrating brain wounds.

Table IV shows the wound distribution by anatomical region of the head. Wounds of the frontal area account for the largest percentage of casualties in both the WIA (41%) and combined DOW and KIA (27%) groups. Parietal, temporal, and occipital wounds are next in order of frequency. The morbid pathology in 60 KIA and DOW cases was classified according to the type and number of bones fractured and the site of injury to the brain (table V). If the cases presenting single bone fractures are compared with those presenting multiple bone fractures, a ratio of 3 to 1 is obtained. However, the number of multiple lobe injuries is greater than the number of multiple bone injuries, which illustrates the tendency for the high velocity missiles used in Vietnam to produce multiple lobe injuries, regardless of the extent of skull fracture. Fracture of the frontal bone was the most common (27%) of the single bone fractures. This was followed by multiple fractures of the vault of the skull (22%). Multiple lobe injury to the brain was predominant; there were 21 cases (35%), and this figure increases to 47% of the total KIA and DOW sample when the brain-avulsion cases are added to the multiple-lobe-injury cases.

Various types of clinical data on the 11 DOW cases obtained at the evacuation hospitals of the 44th Medical Brigade and at the USA Mortuary at Tan Son Nhut are summarized in tables VI and VII. Sixty-four percent of the casualties had single skull fractures, and 36% had multiple skull fractures. However, 72% of the men had multiple injuries to the

brain, while only 28% had single injuries. Direct damage to the CNS was listed as the direct cause of death in eight men. Four of these casualties had subarachnoid, subdural, or epidural hemorrhage as a complicating factor. In only one member of this group of DOW's was trauma outside the head region (abdominal wounds) considered important enough to contribute to death. Even in this case, there was injury to the pons and cerebellar regions, which would probably have produced death by itself. Other reports in the literature have emphasized morbidity of injuries in this area.[3] The average time between wounding and death was 20 hours. However, 72% of these 11 casualties died within 8 hours (table VII).

One of the most interesting groups of this series consists of 11 casualties who survived skull wounds. We have summarized the salient features of each case in this group in tables VIII and IX. In only one instance was the dura mater not perforated. In another instance, there was questionable perforation of the dura mater. All others had lacerations of the brain caused by a missile fracture or, in one instance, by ..condary bone missiles. In five members of this group (50%), the frontal lobe was injured, either alone or in combination with the temporal and parietal lobes. Haynes[5] and Davidoff and Feiring[3] call attention to the excellent prognosis after frontal lobe damage.

Only three of the 11 skull fractures were caused by bullets. In one man a bullet perforated the helmet and caused damage to the frontal, parietal and occipital lobes. In another individual the bullet entered the left parietal area (without helmet protection) and injured the left parietal and occipital lobes. The condition of each man was poor after surgery. One man sustained a bullet wound through his helmet, and there was only parietal bone depression without dural penetration. Referring again to table III, it can be observed that, when all the previous observations are considered, 32 men with penetrating brain wounds survived. This number may be high, because long term followup was beyond the scope of the mission of the data collecting teams.

Tables X to XIV correlate the data on the total sample with the weapons that caused the head wounds. The findings are summarized in tables X and XIII. In the KIA and DOW categories, bullets accounted for 52% of the fractures; fragmenting munitions, for 38%. In the WIA category, a reversed ratio is observed, with bullets accounting for 18% of the wounds, and fragmenting munitions for 77%. Perhaps equally significant, bullets caused the wounds in 20% of the WIA cases with CNS injury, while fragments account for 80% of the CNS injuries within the same group. When tables X and XIII are compared, it is obvious that bullet wounds of the head are more lethal than fragment wounds of the same region. Similar conclusions are reached when table XIV is examined, in which the total number of men with bullet and fragment wounds is correlated with the category of casualty (KIA, DOW, and WIA), and one can see a preponderance of fragment wounds in WIA's with open head injury. Table XI demonstrates that, in fatal cases, bullets produced more multiple injuries to the brain than fragments did. Thus 15 of the KIA and DOW casualties hit by bullets had injuries to multiple lobes of the brain, compared to only 7 of those wounded by fragments.

Table XIII shows that the number of WIA's hit in the head but sustaining no brain injury was much larger for fragments than for bullets.

Tables XV and XVII correlate the use of helmets with the type of missiles that caused the casualty and also with the length of the wound tract. Table XV seems to indicate that bullets are more effective than fragments in perforating the helmet and in producing perforating wounds of the head. Table XVI shows similar data on the WIA cases, but the number of

observations is too small to allow conclusions. Of the 10 cases, five bullets and five fragments perforated the helmet and wounded the head, but did not produce death. The distance from the rifle to the casualty was 75 meters in one instance, and the bullet inflicted a gutter wound of the scalp, indicating on obtuse angle of incidence on impact with the head. In another case the distance from the rifle to the casualty was 15 to 20 meters. The bullet perforated the helmet, penetrated the brain, and destroyed a large area. The wound tract measured 8 cm. However, in this latter case the patient survived, at least during our immediate followup period. In another case, the rifle bullet was fired from a distance of 25 meters, and the casualty suffered a skull fracture; but the bullet did not perforate the dura mater and the prognosis was good. In the two remaining cases, the bullets were fired from a minimum estimated distance of 30 meters and penetrated only soft tissue (the temporal muscle in one case), producing no skull fracture.

In summary, in at least three instances, there is an indication that the helmet was an important factor in retarding the bullet and preventing massive damage to the brain. The sample must be increased before significant conclusions can be drawn, especially if kinetic energy is to be considered.

All five men hit by fragments that perforated their helmets and inflicted wounds to the head survived with only superficial wounds of the scalp, but the distance from detonation to the casualty is not available in three instances.

The data on the relationships between the length of the wound tract and helmet wear shown in table XVII are too sparse to allow evaluation. In tables XVII and XVIII, data from the 65 cases that specified wound-tract length and known weapon are evaluated. The average wound-tract length in the KIA's was longer than in the other categories. The difference between the wound-tract length for the KIA's and the WIA without brain penetration is marked. Between the KIA and the WIA cases with brain penetration, a difference of 20 mm exists in the average wound-tract length caused by all missiles, with the more extensive wounds occurring in the fatalities.

All cases in this study were classified according to their clinical category (table II). The information on the KIA cases is based mainly on the anatomical findings of the total sample; 66 cases correspond to category 6, and 47 cases to category 1. The incidence in the other categories is shown in table II.

IV. CONCLUSIONS.

Most multiple lobe injuries to the brain caused by missiles occur even when skull fracture is not extensive.

The prognosis of multiple lobe injuries is very poor. In our sample of fatalities, 21 (35%) of 60 men sustained this type of injury. This was the largest category of injuries to the CNS in the fatalities.

The association of head wounds with multiple wounds elsewhere in the body did not appreciably increase the risk to life. The brain damage in most of the fatalities was the direct cause of death.

Frontal lobe damage was observed in 50% of the survivors with open head wounds. This finding corresponds with reports in the literature regarding the relatively less severe

prognosis of frontal lobe injury. Conversely, injuries of the parietal area accounted for the largest number of deaths in single lobe injuries.

The regions of the scalp most often struck in both fatalities and survivors are the frontal and parietal areas. The temporal and occipital areas are next in frequency.

The findings suggest that bullets are more lethal than fragments when they hit the head. This is associated with the high frequency of multiple fractures and multiple CNS injuries in casualties hit by bullets.

To reach significant conclusions regarding the relative lethality of one bullet over another or fragments from one kind of munition over another, a larger sample must be studied.

The data suggest that the helmet offers more protection against fragments than against bullets and may retard a bullet sufficiently to convert a potentially perforating wound into a penetrating one.

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APPENDIX

TABLES

Table I. Classification of Casualties According to the Categories of Closed and Open Head Injuries

Type of casualty	Open head injury (dural penetration): Skull fractured, dura mater lacerated and brain injured		Closed head injury (no dural penetration): Skull fractured, dura mater not lacerated		Scalp and galeal wounds only	
	Total	Percent[a]	Total	Percent[a]	Total	Percent[a]
KIA[b]	49	41	-	-	-	-
DOW[c]	11	9	-	-	-	-
WIA[d]	10	8	1	1	49	41
Total	70	58	1	1	49	41

[a]Percent of total sample (120).

[b]KIA = Killed in hostile action.

[c]DOW = Died of wounds.

[d]WIA = Wounded in action.

Table II. Classification of Casualties According to Clinical Categories[a]

Type of casualty	Number of casualties in each category					
	1	2	3	4	5	6
KIA	-	-	-	-	-	49
DOW	-	-	-	-	-	11
WIA with skull fracture	1	-	-	1	3	6
WIA without skull fracture	46	3	-	-	-	-
Total	47	3	-	1	3	66

[a]See page 9.

Table III. Casualties with Head Perforation, Brain Penetration, and Brain Avulsion

Type of wound	KIA and DOW		WIA	
	Number	Percent[a]	Number	Percent[b]
Perforating	27	45	0	-
Penetrating	22	37	10	16
Avulsion	7	12	0	-
Unknown	4	6	0	-
Totals	60	100	10	16

[a]Percent of total (60) KIA's and DOW's.

[b]Percent of total (60) WIA's. One casualty had a skull fracture, but no perforation of the dura mater and is not included in this tabulation. One casualty had brain contusion together with skull fracture. Laceration of the dura mater in this casualty was questionable; however, it was decided to include this case in the group of penetrating injuries.

Table IV. Wound Distribution by Anatomical Region of the Head

Anatomical region hit	KIA and DOW		WIA	
	Number	Percent	Number	Percent
Frontal	16	27	25	41
Parietal	10	17	14	23
Occipital	5	8	6	10
Temporal	8	13	10	17
Facial region	1	1	-	-
Multiple areas	15	25	1	2
Eyes and eyelids[a]	2	3	3	5
Not specified	3	6	1	2
Total	60	100	60	100

[a]Considered as separate category from facial region because of proximity to frontal bone, horizontal portion.

Table V. Distribution of Fractures and CNS Injuries (KIA and DOW)

Location of injury	Number	Percent
Bone fractured:		
Frontal	16	27
Parietal	10	17
Occipital	5	8
Temporal	8	13
Base of the skull	3	5
Facial skeleton	1	1.5
Multiple fractures of vault	13	22
Avulsion of skull	1	1.5
Not specified	3	5
Total	60	100
CNS region injured:		
Frontal lobe	4	6
Parietal lobe	7	12
Occipital lobe	-[a]	-
Temporal lobe	1	2
Cerebellum	2	4
Cerebral hemisphere	5	8
Spinal cord, medulla	4	6
Multiple injury (several lobes)	21	35
Brain avulsion	7	12
CNS injury not specified	9	15
Total	60	100

[a]Occipital lobe injuries occurring in association with other lobe injuries are included under multiple-injury category.

Table VI. Clinical Data on DOW Casualties

Case number	Skull fracture		Brain damage			Surgery	Complications	Direct cause of death	Contributing cause	Interval to death[a]
	Single	Multiple	Single	Multiple	Massive					
80022-2	-	X	-	-	X	Control of hemorrhage	Cerebrospinal fluid leak, hyperthermia	Massive injury, right hemisphere		3 hr
80038-5	X	-	-	X	-	Craniotomy		Injury to pons and cerebellum	Abdominal wounds	5 days
80077-1	-	X	-	-	X	Craniotomy		Brain laceration	Pulmonary edema	3 days
80088	X	-	-	-	X	Evacuated[b]	Subarachnoid hemorrhage	Brain laceration		1 hr
70128	X	-	-	X	-	Craniotomy		Brain laceration		7 hr
70198	-	X	X	-	-	Tracheostomy	Intra-maxillary hemorrhage	Brain laceration	Aspirated blood	2½ hr
70119	X	-	-	-	X	Tracheostomy	Subdural hematoma	Brain laceration		12½ hr
70212	X	-	-	X	-	Evacuated[b]	Cranial, extra and subdural hemorrhage	Massive hemorrhage		90 min
80380	-	X	-	X	-	Evacuated[b]		Cerebral edema	Pulmonary edema	6 hr
80402-2	X	-	X	-	-	Unknown	-	Unknown		2½ hr
80402-36	X	-	X	-	-	Unknown	-	Unknown		2 hr
Total	7	4	3	4	4	-	-	-	-	-
Percent	64	36	28	36	36	-	-	-	-	-

[a]Average time to death was 20 hr.
[b]Casualty taken from Evacuation Hospital to another medical facility.

Table VII. Head Trauma: Time to Death for DOW Casualties

Interval to death	Number of cases
Hours:	
1-2	2
2-3	3
3-4	1
4-5	-
5-6	-
6-7	1
7-8	1
8-9	-
12½	1
72	1
120	1

Table VIII. Type of Wounds, Weapons, and Helmet Wear: 11 WIA with Skull Fracture

Case number	Skull fracture	CNS Injury	Wound tract, in mm.	Weapon and distance	Helmet data	Remarks
80347-14	Right frontal and occipital comminuted	Frontal, parietal and occipital lobe	234	Rifle, 15-20 m	Hit and perforated	Entrance in right frontal region
80299-1	Left parietal depressed	None	75 (gutter)	Bullet, 25 m	Hit and perforated	Dura mater not perforated
70029-1	Left orbital bones	Frontal	120 100	Cluster bomblet unit 1-2 ft	Worn not hit	2 fragments
80227-5	Left parietal	Left parietal and occipital lobes	120	Rifle	Not worn	-
70018-41	Frontal depressed (midline)	Contusion to both frontal lobes	-	122-mm rocket, 13-18 m	No information	No laceration of brain, only contusion because of fracture
70018-45	Left temporal	Temporal and parietal lobes	100	Fragment	No information	Secondary (bone) missiles produced CNS injury
80126-8	Left parietal	Occipital and temporal lobes, left	125	Rocket 2.75", 15-25 m	Worn, not known if hit	-
80318-2	Right frontal depressed comminuted	Frontal	100	Hand grenade M26, 1 m	No information	Minimal brain damage, good prognosis, fragments in brain
80286-2	Left and right parietal (2 entrance wounds)	Left and right parietal lobes and occipital lobes	Left 57 Right 92	Fragments (2)	No information	2 fragments penetrated CNS
80295-1	Right parietal	Left temporal lobe	140	Fragment	No information	-
80333-3	Frontal	Frontal and left temporal lobes	140	Hand grenade M26, 6-10 m	No information	-

Table IX. Evacuation and Clinical Data: 11 WIA with Skull Fracture

Case number	Time to evacuation[a]	Time to surgery	Surgery	Clinical category	Other trauma and surgery	Remarks
80347-14	20 min	20 min	Craniotomy, debridement, and dural graft	6.-Profound dural and brain penetration	-	8 cm area of laceration in the frontal, parietal and occipital lobes
80299-1	25 min	25 min	Scalp debridement, removal of depressed bone	1.-No neurological significance	-	Missile did not perforate dura mater
70029-1	Unknown	1 hr 50 min	Craniotomy, debridement of CNS tissue	6.-Profound dural and brain penetration	Laparotomy with liver suture, eye enucleation	
80227-5	Unknown	6 hrs	Craniotomy, debridement of brain	6.-Profound dural and brain penetration	-	Evacuated to 249th Gen on 6th postop[b] day
70018-42	Unknown	2 hrs 30 min	Debridement of frontal bone, explanatory craniotomy	5.-Questionable dural penetration	-	No laceration of brain at craniotomy
70018-45	Unknown	1 hr 30 min	Craniotomy, debridement of scalp and brain	5.-Penetration of dura by secondary missiles	-	Injury produced by secondary bone fragment, injury to speech motor center
80126-8	20 min	Unknown	Craniotomy, debridement of CNS tissue	5.-Dural penetration with neurological deficit	-	Hemianopsia, transferred to Japan 4th postop day
8J295-1	15 min	1 hr	Craniotomy, debridement of brain tissue	6.-Profound dural and brain penetration	-	Postop unknown
80333-3	3 to 5 min	Unknown	Craniotomy, debridement of brain tissue	6.-Profound dural and brain penetration	Tracheostomy, multiple fragment wounds of extremities	Transfer on 6th postop day

[a]Evacuation time is from arrival at landing zone until arrival at evacuation hospital.
[b]Postoperation.

Table X. Head Trauma: Correlations of Type of Missile with Skeletal and CNS Injury (KIA and DOW)

Location of injury	Number of cases for each missile		
	Bullets	Fragments	Unknown
Bone fractured:			
Frontal	8	7	1
Parietal	4	4	2
Occipital	2	1	2
Temporal	5	3	-
Base of skull	2	1	-
Facial bones	1	-	-
Multiple vault fracture	5	6	1
Combined base and vault	1	-	-
Massive avulsion	1	-	-
Orbit	1	1	-
Not specified	1	-	-
Total	31	23	6
CNS region injured:			
Frontal	1	2	1
Parietal	3	3	1
Occipital[a]	-	-	-
Temporal	-	1	-
Cerebellum	2	-	-
Pons, medulla	3	1	-
Multiple lobe	13	6	2
Both cerebral hemispheres	2	1	2
Massive brain injury	1	6	-
Not specified	6	3	-
Total	31	23	6

[a]Other cases with occipital lobe injury are listed in the multiple-lobe category.

Table XI. Correlation of Type of Missile with Skeletal and CNS Injury (KIA and DOW), Main Regions of Trauma

Identification of weapon	Bone fracture[a]						CNS region injured[b]					
	Frontal	Parietal	Temporal	Multiple vault	All others combined	Total	Multiple lobe	Massive	Parietal	Both hemi-spheres	All others combined	Total
	number/percent						*number/percent*					
Bullets	8/25	4/12	5/16	5/16	9/29	31/100	13/42	1/3	3/9	2/6	12/40	31/100
Fragments of munitions	7/30	4/17	3/13	6/26	3/13	23/100	6/26	6/26	3/13	1/5	7/30	23/100
Unknown weapon	1/16	2/33.3	–	1/16	2/33.3	6/100	2/33.33	–	1/16 66	2/33.33	1/16 66	6/100
Total	16/26	10/17	8/13	12/20	14/24	60/100	21/35	7/12	7/11	5/8	20/34	60/100

[a]Areas with 13% or more representation, others are combined in one category.

[b]Areas with 8% or more representation, others are combined in one category.

Tabie XII. Head Trauma: Correlation of Bullet and Fragmenting Munitions with Head Wounds (WIA)

Identification of weapons	Wounds producing injury to brain, with region of CNS injured			Wounds of head without brain injury, showing region of head hit				
	Frontal lobe	Multiple lobe injury	Multiple areas	Frontal	Parietal	Occipital	Temporal	Facial
Bullets:								
5.56 mm	-	-	-	-	-	-	1	-
7.62 x 39	-	-	-	-	-	-	1	-
Rifle bullet	-	2	-	3	1	-	1	-
Unknown bullet	-	-	-	-	1	-	-	-
7.62 x 25 mm	-	-	-	1	-	-	-	-
Fragmenting munition:								
Hand grenade M26	1	1	2	-	1	1	-	-
Hand grenade MKII	-	-	-	1	-	1	-	-
M79	-	-	1	1	-	-	-	-
60-mm mortar	-	-	-	-	1	-	-	-
81- and 82-mm mortar	-	-	-	2	-	2	2	-
Unknown mortar	-	-	-	1	-	-		-
105-mm howitzer	-	-	-	1	-	-	-	-
2.75-mm rocket	-	1	1	1	-	-	-	-
122-mm rocket	-	1	-	1	-	-	-	-
57-mm recoilless rifle	-	-	-	1	-	-	-	-
RPG-2	-	-	-	2	2	-	-	-
Cluster bomblet unit	-	-	1	2	-	-	-	1
Hand grenade, unknown type	1	-	1	3	1	-	1	1
Unknown fragment	-	3	-	-	1	-	1	1
Unknown weapon	-	-	-	1	-	-	1	1

Table XIII. Correlation of Missile Agent with Head Wounds (WIA)

Identification of missile	Wounds producing injury to brain with region of CNS injured		Wounds of head without brain injury, showing region of head hit						
	Frontal lobe	Multiple lobe injury	Frontal	Parietal	Occipital	Temporal	Facial	Multipie areas	Total
									number/percent
Bullets	-	2	4	3	-	2	-	-	11/18
Fragmenting munition	2	6	14	6	4	6	3	5	46/77
Unknown weapon	-	-	1	-	-	1	1	-	3/5
Total (number/percent)	2/3.	8/13	19/32	9/15	4/7	9/15	4/7	5/8	60/100

Table XIV. Summary of Correlation Between Type of Missile and Injury (KIA, DOW, and WIA)

Weapon	Incidence of bone fractures[a]	Incidence of CNS injury[a]
	number/percent	*number/percent*
KIA and DOW:		
Bullet	31/52	31/52
Fragment	23/38	23/38
Unknown	6/10	6/10
Total	60/100	60/100
WIA:		
Bullet	3/28	2/20[b]
Fragment	8/72	8/80
Total	11/100	10/100

[a]Each instance represents a case with single or multiple bone fractures and single or multiple injury to the CNS.
[b]One instance of skull fracture occurred without CNS injury.

Table XV. Correlation of Helmet Wear With Missile: 24 KIA and DOW Cases With Accurate Data

Helmet wear	Number of cases per weapon								Number of cases per type of wound			
	Bullet				Fragment							
	Perforating	Penetrating	Unknown	Total	Perforating	Penetrating	Total	Total	Perforating	Penetrating	Unknown	Total
Helmet perforated	7	5	1	13	1	1	2	15	8	6	1	15
Helmet not worn or struck[a]	3	1	-	4	2	3	5	9	5	4	-	9
Total	10	6	1	17	3	4	7	24	13	10	1	24

[a]The missile hit the head in an area not protected by a helmet, or the casualty was not wearing a helmet.

Table XVI. Correlation of WIA's Helmet Wear with Missiles Causing Wound

Missile	Helmet perforated	Helmet not worn or not struck	No information	Total
	number/percent	*number/percent*	*number/percent*	*number/percent*
Bullet	5/8	4/7	–	9/15
Fragment	5/8	27/45	19/32	51/85
Total	10/16	31/52	19/32	60/100

Table XVII. Relationships Between Length of Wound Tract and Helmet Wear (KIA and DOW)

Wound tract in mm.	Helmet perforated		Helmet not worn	
	Total	Percent WG[a]	Total	Percent WG[a]
0-100	1	9	1	10
101-150	7	64	6	60
151-200	2	18	2	20
Over 200	1	9	1	10
Total	11	100	10	100

[a]Percent within the group.

Table XVIII. Correlation of the Type of Missile and Casualty for Which the Weapon and Wound-Tract Length Were Known

Case classification	Average wound-tract length (Thickness of penetration)			Total number of cases in sample[b]
	Bullets	Fragments	Average[a]	
	mm	*mm*	*mm*	
KIA	152	130	145	25
DOW	126	131	124	7
WIA with brain penetration	143	116	128	10
WIA without brain penetration	40[c]	15	17	23
Average	115	98	-	-

[a]Average of individual observations for both categories.

[b]Superficial abrasions, grazing wounds, avulsion, and massive wounds without measurable wound tract are not included.

[c]Tangential wound measurement in scalp are included.

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HEAD TRAUMA: ANALYSIS OF 120 CASUALTIES IN VIETNAM FROM JULY 1967 to JANUARY 1968

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5 AUTHOR(S) *(First name, middle initial, last name)*

MAJ Ian Sunshine, MC, LTC Herman A. Campana, MC and 1LT Harold T. Smith, Jr., MSC

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11. SUPPLEMENTARY NOTES	12. SPONSORING MILITARY ACTIVITY
Head trauma Casualties Vietnam	

13 ABSTRACT

To assist in the development of models for the study of head injury, 120 consecutive case histories on men who sustained head wounds were selected for analysis from the files of the Wound Data and Munitions Effectiveness Team at Edgewood Arsenal. The sample consists of 60 men who died and 60 who survived. These casualties were incurred by combat units of the US Army in Vietnam during the period of July 1967 to January 1968. It was concluded that when the brain is penetrated by a missile in combat, the prognosis is poor. Only 31% of our sample with penetrating injuries (32 cases) survived this type of injury. The prognosis of multiple lobe injuries is very poor. In our sample of fatalities, 21 of 60 men (35%) sustained this type of injury. This was the largest category of injuries to the central nervous system in the fatalities. Frontal lobe damage was observed in 50% of the survivors with open head wounds. This corresponds with reports in the literature regarding the relatively less severe prognosis of frontal lobe injury. Conversely, injuries of the parietal area accounted for the largest number of deaths in single lobe injuries. The data suggest that the helmet offers more protection against fragments than against bullets and may retard a bullet sufficiently to convert a potentially perforating wound into a penetrating one.

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14. KEY WORDS	LINK A		LINK B		LINK C	
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EDGEWOOD ARSENAL
Technical Support Directorate
Edgewood Arsenal, Maryland 21010

ERRATUM SHEET

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This report was forwarded to your installation on 16 March 1970.

The changes to be made are as follows:

Page 8 — Second Paragraph: Second sentence should be deleted and replaced by the following: In the combined KIA and DOW group 27 casualties, or 45%, had perforating head wounds and 22 (37%) had penetrating brain wounds. On the other hand, in the WIA group no men had perforating wounds and only 10 (16%) had penetrating brain wounds.

Page 9 — Third Paragraph; 6th sentence: The sentence now reads: Referring again to table III, it can be observed that, when all the previous observations are considered, 32 men with penetrating brain wounds survived. It should be changed to the following: Referring again to table III, it can be observed that, when all the previous observations are considered, 32 men had penetrating brain wounds and of these only 10 (31%) survived.

Henry J. Bielecki

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