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THE EXPERIENCE OF SOVIET MEDICINE IN THE GREAT PATRIOTIC WAR 19--ETC(U)  
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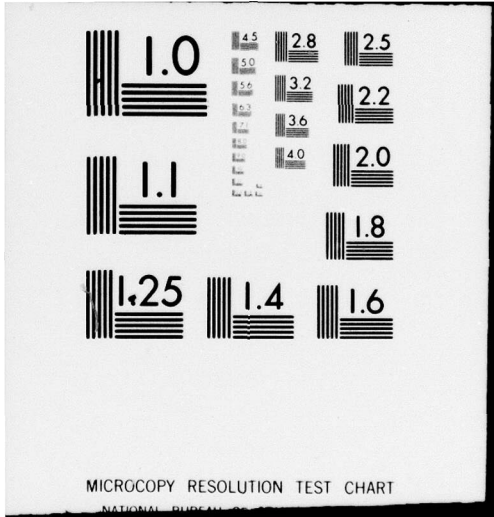
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The Experience of Soviet Medicine in the  
Great Patriotic War

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## Gunshot Wounds

### Chapter I

## Gunshot Wounds

### Basic Concepts

In modern wars the overwhelming majority of losses are gunshot wound casualties. The shells used to destroy forces and defended installations differ greatly, and this variety and destructive force have a steady tendency to increase. The methods for guiding shells to the target are equally varied. In addition to simple hand throwing, the most complex aiming systems and mechanisms are used. The effective range of modern means of destruction is also steadily increasing. In addition, in recent decades shells moving through the air or water using special mechanisms built into the shells themselves have been used more and more. These include naval torpedos, rocket-assisted shells, and the flying bombs used by the Germans.

The injuring effect of all types of weapons used are a function of the kinetic energy of the wounding missile at the moment it strikes the tissues.

As opposed to the situation in previous wars, there are very few casualties from cutting weapons (sabers, lances, and even bayonettes) and they have no practical significance. Cutting weapons played an important role in hand-to-hand combat in the time of Suvorov and Kutuzov, not to mention ancient wars. However, even N.I. Pirogov noted that "In general, significant wounds from cutting weapons were rare during the Crimean War". In wars in this century, the frequency of casualties caused by cutting weapons has continued to decrease. During the Russo-Japanese War, 1904-1905, the frequency of casualties by cutting weapons in the Japanese army was 3.0%. In World War I, 1914-1918, the frequency of cutting wounds in the German army dropped to 0.6%, and further to 0.02% during World War II in the years 1939-1941.

In the Soviet Army during the Great Patriotic War, these casualties also totalled 0.02%. Their frequency during various combat operations varied from tenths of a percent to 0.02%. For example, the percentage of casualties from cutting weapons compared to the total number of casualties was equal to zero<sup>1</sup> during the Battle of Stalingrad, 01.% during the Orlovsk-Kursk operation,

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<sup>1</sup>These data are given only for the period when the 6th German Army surrounded at Stalingrad was liquidated.

0.02% during the Belorussian operation, 0.07% during the Vistula-Oder operation and 0.2% during the Berlin operation.

The percentage of bullet wounds decreased while the percentage of artillery wounds increased. Wounds by shell and hand grenade fragments appeared, as is evident from Table 1.

Table 1. Breakdown of Wounds by Type of Wounding Weapons in Various Wars

	Rifle Bullets	Artillery Shells	Mines	Hand Grenades	Secondary Missiles
	Percentage of Wounds				
Russian Army, 1904-1905	78.6 <sup>1</sup>	21.4 <sup>1</sup>	--	--	--
French Army, 1917 (static warfare)	11.6	55.9	0.9	10.3	21.3
French Army, 1918 (maneuver warfare)	14.7	53.9	0.3	6.7	24.4

This is explained by the change in the nature of warfare during direct contact with the enemy, namely by the wide use of hand grenades and point-blank fire since automatic weapons do not require time for reloading and are always ready for action.

In addition, from the surgical point of view, wounds due to cutting weapons, other conditions equal, are generally less severe than gunshot wounds. N.I. Pirogov wrote: "However, all of these wounds (i.e., from cutting weapons) disappeared during the siege under the flood of wounds inflicted by powerful, previously unheard-of shells". All of the difficulties in surgical treatment were connected with gunshot wounds, and not with wounds from cutting weapons.

Wounds from so-called secondary missiles, i.e., stones, clumps of frozen dirt, and fragments of metal, wood, glass, etc. during the explosion of artillery shells, mines, aviation bombs, etc. are almost identical to gunshot wounds and from the surgical point of view may be combined with them (Figure 1). Thus, gunshot wounds are the focus of attention for the modern doctor during a war. In both properties and peculiarities, as well as frequency, they occupy the first place in contemporary military field surgery.

<sup>1</sup>According to Kaminsky and Novosel'skiy

If we consider all the means of destruction used during the Great Patriotic War by the German armed forces and their satellites, as well as the ballistic properties of the widely varying shells used, then their critical effect on human tissues becomes understandable.

More than 500 years have passed since the introduction of firearms into military practice. During this period firearms technology has achieved vast successes. From their very first acquaintance with gunshot wounds, doctors strove to study their special features, the results of the clinical course of wounds and their propensity to complications during healing.

The first reports about gunshot wounds, or more precisely about the extraction of bullets, are dated August 2, 1445 [Brunner], 1444 according to other information, while the first description of a special instrument for probing a wound for a bullet was given by the surgeon Pfolspeund in 1460.

Obviously, the presence of a foreign object in the wound first received the most attention and served as the foundation for describing the new type of wound. Later, however, greater attention was attracted by the other property of gunshot wounds: the course of a gunshot wound was incomparably more severe than that of conventional wounds, with this tendency toward complications being observed not only when the bullet or fragment was left in the wound, but also in wounds where the missile had passed completely through. Much time and effort were required to explain the cause of tissue damage in cases of gunshot wounds. Clearly, the study of these began to yield valuable results when the researchers proceeded with experiments in addition to clinical observation. Many works both here and abroad were devoted to the topics mentioned above. Of the works of Russian authors, we must cite the research by K.K. Reyer, M.M. Rozanov, Ye. V. Pavlov, V.A. Tile, I.N. Kochetov, A.A. Glebovich, A.A. Opokin, etc.

The first experiments on the passage of a bullet through various media were made in 1830 by Dyunyuitren.

18 years later (1848), N.I. Pirogov checked Dyunyuitren's data on models and cadavers and confirmed that when a bullet passed through a medium, the exit wound was always larger than the entry wound and that there was a definite pattern when a bullet struck a concave or convex surface. On the basis of his experiments and subsequent observations in Sevastopol relating to round and conical bullets, N.I. Pirogov felt that the data obtained on wooden or felt models could not be applied to humans.

Modern research, during which all of the capabilities of

modern technology, namely photography and x-ray tests on a missile in flight, when passing through an experimental medium (water, a gelatine solution, etc.) or through the tissues of an experimental animal were used, acquired the greatest significance for understanding the nature of tissue damage. Single frames were taken in one millionth of a second, and motion pictures were taken at a rate of from 2000 to 7000 frames per second at a missile speed of from 338 to 1300+ m/sec, which corresponded to the bullet muzzle velocities of modern weapons. It had long been known that significant tissue contusion took place along the wound channel in a case of a gunshot wound, but now it was possible to photograph the action of the metallic object (ball or bullet) passing through tissue and precisely calculate the force of impact.

A steel ball weighing 0.439g traveling at a speed of 1157.8 m/sec develops an impact energy equal to  $29.02 \cdot 10^8$  ergs. Since the destruction taking place in the tissues is a function of the speed, shape and mass of the wounding missile on the one hand and the physical properties of the damaged tissues on the other, the combination of these factors and the conditions surrounding their effect cause great variety in wounds.

In all perforating wounds, as in blind wounds, the force of impact and the speed of the missile are great, thus explaining the characteristics of a gunshot wound.

The kinetic energy with which a wounding object penetrates tissue drops to zero in blind wounds due to the resistance of the tissues, while in perforating wounds it is only partially dissipated with the residual amount carrying the wounding object out.

Observation of the effect of a missile during firing was conducted with steel balls, bullets and odd-shaped fragments, with the flight of the missiles being studied on anesthetized animals as well as on models of various shapes with solid and elastic walls filled with water or a gelatine solution. It turned out that, under the effect of the impact, a shock wave appears from the compressed tissues (or solution) in front of the missile at the moment the foreign object penetrates the medium, sharply deforming the model. Simultaneously, a sort of void is created behind the foreign object which then moves along the wound channel. However, these deformations are very brief, lasting only thousandths of a second, arising and disappearing in an undulating manner.

Within the brief time of the passage of a bullet through the body of an experimental animal, two to three waves are observed.

N.I. Pirogov himself noted that hemorrhaging and other results of damage could be detected far from the wound channel; this should be expected even more in cases of wounds by modern bullets and fragments, which have much higher speeds than those in the time of N.I. Pirogov.

Tests by pathoanatomists, in particular the research by A.V. Smol'yannikov on amputated extremities and cadavers, detected the presence of tiny fragments of the femoral bone throughout the medullar channel, as well as tiny hemorrhages as a result of this splashing of bone fragments.

When studying the results of the experiments mentioned above, it is necessary to note on the basis of morphologic data that in a case of a gunshot wound the trauma causes notable changes far beyond the area of direct contact between the wounding missile and the tissues. However, the morphologically determined results of a wound are observed much less frequently than would be expected on the basis of experimental data. Obviously, short-term effects which disappear in infinitesimal fractions of a second are important here. It is very difficult to determine those changes in tissues which are not morphologically pronounced, but without a doubt they exist and cause functional disruptions. We can only assess them by studying the subsequent course of the wound process and the overall reaction of the organism, as well as on the basis of the complications which are so frequent after gunshot wounds. This entire complex of local and systemic phenomena should be viewed on the whole as damaging not only a certain area, but the entire organism.

It is therefore not surprising that during the 15th Century, in the light of surgical observation of the course of gunshot wounds, certain scientists erroneously called them poison wounds, with the toxic effect being ascribed to the gunpowder.

Gunshot wounds and the surrounding tissue are actually damaged not by "poisoning" from gunpowder, but rather as result of the abrupt and quick fluctuations in pressure which appear during passage of the wounding missile through the tissues due to its high speed, the source of which is the explosive.

Thus, in contemporary understanding the genesis of a gunshot wound is primarily due to the abrupt "explosive" fluctuations in pressure in the tissues, where the foreign object primarily plays the role of a carrier of kinetic energy, with its speed causing an "interstitial explosion". Of course, the presence of a foreign object in the tissues affects the further course of the wound, but during the Great Patriotic War there were many injuries where the wound appeared as a result of the shock wave alone. If small



Figure 1. Secondary Missile Wound. Stone in the lung. VMM Test No. 3531/388 (Artist: S.A. Mosheyeva)

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Figure 2. Lacerated Wound of the Right Hand with Avulsion of the 1st Finger. Wounded during explosion of a grenade in the hand. VMM test No. 2921/66 (Artist: S.A. Mosheyeva)

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Figure 3. Crushed Foot: Wounded by an AP mine.  
VMM test No. 6945/68 (Artist: M.N. Sakulyari)

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particles of metal, bits of clothing and bits of moss, soil or turf were found in the wound, they were only random foreign objects introduced by the force of the explosion. Such wounds were caused, for example, by AP mines; as is well known, the latter cannot have metallic housings: the explosive charge is contained in a wooden or even paper casing.

Tissue destruction caused by a shock wave sometimes reaches significant proportions (Figures 2 and 3). Such a wound is often observed after the explosion of a grenade in the hand. Such wounds were impregnated with a mass of small metallic fragments, but the cause of the destruction was the force of the shockwave rather than these fragments.

The nature of changes is a function of the force of the shock, which in itself is dependent on the distance between the soldier and the wounding weapon, including the distance from the explosion of an artillery shell or a bomb.

As was already noted, it is necessary to consider the changes in the organism which have no morphologic reflection. Some of these occur in the subsequent course of the wound process, and some may be detected by comparison with the course of non-gunshot wounds. Finally, the matter is also complicated by the fact that various tissues in the human body react differently to a shock or "explosion". This peculiarity has an effect in cases of wounds which damage tissues with various structures and densities, bone tissue in particular. The conditions for the propagation of a shockwave in tissues of various structures change the nature of damage. For example, when a missile passes through the brain, which is enclosed in the dense cranial case, tissue destruction is entirely different from that during the passage of a missile through lung tissue containing air. Other conditions exist during the passage through massive muscular tissues, the bones surrounded by them, etc. In view of this, N.I. Pirogov came to the conclusion that "the differences in effects on organic tissues are endless". It was clear that the most important feature of a gunshot wound was the interstitial "explosion" and the fluctuations connected with it, which did not and could not exist in cases of wounds by cutting weapons. Therefore, damage from these wounds has a much more localized nature: in a cut the damage is almost completely limited to the wound itself, while in contused, lacerated and crushed wounds it to a certain degree covers the wound edges, but on a much smaller scale than in a case of a gunshot wound.

#### General Characteristics of Gunshot Wounds

During the Great Patriotic War gunshot wounds were more

common than in all previous wars. If we subtract the number of cutting wounds from the total number of wounds, then 99.98% of all wounds were gunshot wounds, including damage by secondary missiles.

Gunshot wounds are subdivided into bullet and fragment wounds. In the majority of cases, it is possible to apply such division with high reliability. However, with regard to fragment wounds from various causes, here the documentary data make it possible to only approximate since some of the records are based only on the accounts of the casualties.

In cases of perforated wounds, a judgement about the wounding missile can be made only on the basis of the nature of the wound. It is not always possible to correctly determine the nature of the wound, while after surgical treatment it is frequently impossible.

In cases of blind wounds, it is easy to recognize a bullet wound from an x-ray, but for fragment wounds it is far from always possible to conclude what caused them (fragments from artillery shells, mines or bombs) if the conditions of the combat situation in which the wound was inflicted are not known.

This question was not always correctly settled even when the fragment was removed since the shape, external appearance and composition of fragments are extremely varied and the evaluations were made by doctors who sometimes were unfamiliar with the wounding missiles.

Thus, precise differentiation of fragment wounds is not always possible. A precise conclusion about the source of a fragment or the explosive nature of a bullet can be made only after careful and thorough examination.

The ratio of fragment and bullet wounds throughout the entire war was expressed as 57 : 43 (56.8 : 43.2). This ratio corresponds to the increasing frequency of fragment wounds in comparison with bullet wounds which was observed in each of the previous wars due to the increasing role of artillery, the increase in gun caliber and the wide use of mortars and aircraft. However, this predominance of fragment wounds was offset by the very wide use of automatic rifles and machineguns in the German army.

The predominance of wounds from artillery shells in World War I was great, which is clear from the example of the American army, which entered this war during the period of greatest development of all forces of destruction. For example, 72.0% of all wounds of a precisely explained source was attributed to artillery shells

and only 28% were bullet wounds.

However, here it must be noted that the number of artillery wounds also includes shrapnel wounds. In the Soviet army during the Great Patriotic War, there were almost no shrapnel wounds.

The comparative frequency of bullet and fragment wounds by the years of the war are presented in the following diagram (Figure 4).

As is evident from this diagram, bullet wounds occurred most frequently in the first year of the war. In the second year of the war, an increase in the frequency of fragment wounds and a corresponding decrease in the number of bullet wounds was noted. The third year of the war showed the same increase in the frequency of fragment wounds, and consequently the same decrease in the frequency of bullet wounds. In the fourth year of the war, fragment wounds increased slightly more in comparison with the previous years. Thus, the frequency of fragment wounds increased with each year of the war, as did the severity of the wounds and their tendency toward complications.

The variations in the frequency of fragment and bullet wounds during individual combat operations were significant depending on the combat situation. There was a vast prevalence of bullet wounds when breaking up and destroying surrounded enemy groups, when the number of bullet wounds sometimes exceeded 80% of the total on the front conducting this operation.

Here, the very high percentage of multiple wounds must be noted. For example, bullet wounds were multiple wounds in one-third of the cases, this ratio being maintained throughout all four years of the war, while only two-thirds of all bullet wounds were singular. The ratio of singular and multiple fragment wounds was just as high, with the number of such wounds for each year and for the entire war being almost identical, with a slight predominance (1.0-2.0%) of multiple wounds.



Figure 4. Comparative Frequency of Bullet and Fragment Wounds During the War.

Thus, all wounds as a whole maintained a constant relationship throughout the years of the war, namely, three-fifths of all wounds were singular wounds and slightly more than two-thirds were multiple wounds. Such a high percentage of multiple wounds has not been observed during previous wars.

As is well known, the sites of combat injuries are a function of the comparative sizes of various parts of the body and their positions at the instant when the wound was inflicted. In previous wars, a certain pattern in injuries to individual areas of the body had already been established.

However, significant variations are encountered in individual operations. Therefore, when evaluating data the levels of such variations are more important than the average figures. The latter are used only to show the dynamics in the frequency of a wound at a given site for the war years.

If we disregard rare cases caused by special conditions, then the limits of the variations for various wound sites are expressed by the following figures: head wounds - 7.0-13.0%, neck wounds - 0.5-1.5%, chest wounds - 7.0-12.0%, wounds to the abdomen - 1.9-5.0%, wounds to the back, waist, and buttocks - 5.0-7.0%, wounds to the spine - 0.3-1.5%, wounds to the upper extremities - 29.0-45.0%, and wounds to the lower extremities - 30.0-40.0%.

The figures given relate to various fronts, large combat operations and areas of a front during relative quiet between major combat operations. It is clear from these figures that the basic pattern in wound sites prevails, i.e., the greatest number of wounds occur in the extremities. However, important tendencies with regard to the frequency of wound sites during the Great Patriotic War may be determined if we consider data for individual years. For this purpose the curves given below were plotted where the frequency of wounds in a given area during the first year of the war is taken as the initial data, and the frequency of those same wounds during the three subsequent years is placed on a curve above or below this, respectively. The curves are not plotted to scale in order to more clearly show the frequency of a given wound site. A special mark (O) shows the average frequency of wounds to a given area throughout the war; here it is easy to judge the period of the war to which the average wound frequency corresponds.

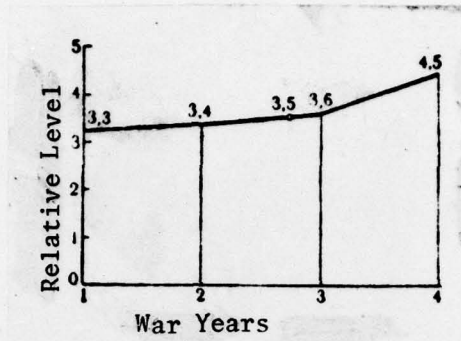


Figure 5. Comparative Frequency of Head Wounds by War Years

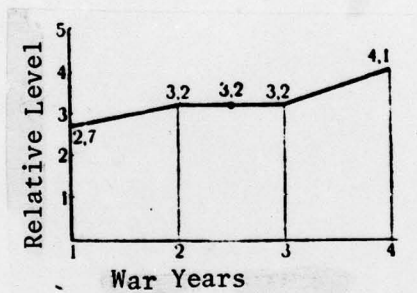


Figure 6. Comparative Frequency of Neck Wounds by War Years

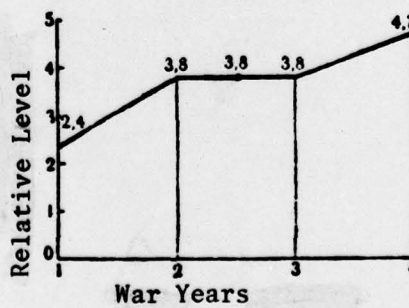


Figure 7. Comparative Frequency of Chest Wounds by War Years

[Commas indicate decimal points.]

The curve for head wounds (Figure 5) shows a uniform increase in the frequency of such wounds in the second and third years of the war and an even more significant increase in the fourth year.

The curve for the frequency of neck injuries (Figure 6) shows a tendency to rise, but it is insignificant and the actual frequency of neck wounds was steady throughout the entire war. Clearly, the average number of wounds is located along the middle of the curve.

The curve for chest wounds by war years (Figure 7) gives a different picture. The frequency of injuries was uniform in the second and third years of the war, corresponding to the average level of the entire war; with regard to the first and fourth years, they balance each other: the first toward a reduction from the average level and the fourth toward an increase.

The frequency of wounds in the area of the abdomen increased completely uniformly (Figure 8); the average figure lies between the second and third years of the war.

The frequency of wounds to the spine (Figure 9), as is visible, was constant throughout the entire war. The tendency in the frequency of such wounds to rise was very slight.

At first the curves are arced for wounds to the back, waist, and buttocks (Figure 10). A slight increase in the frequency of such wounds in the second year of the war, a slightly smaller increase in the third year and a clear drop in the fourth year were observed. However, the frequency of wounds in these areas in the fourth year of the war was nevertheless higher than the first. The average figure is lower than for the second year of the war.

The curve for the frequency of wounds to the lower extremities (Figure 11) increases with each year of the war. The average figure is near the level for the second year but slightly above it.

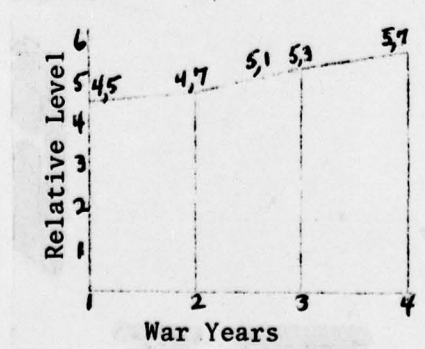


Figure 8. Comparative Frequency of Wounds to the Abdomen by War Years [Commas indicate decimal points.]

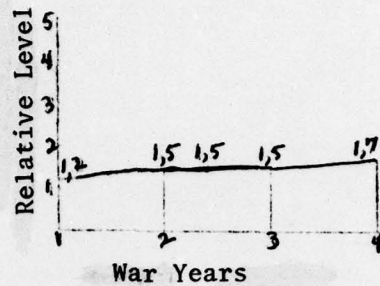


Figure 9. Comparative Frequency of Wounds to the Spine by War Years  
[Commas indicate decimal points.]

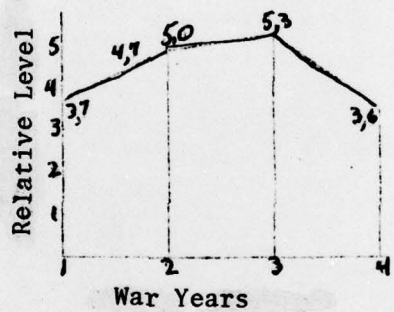


Figure 10. Comparative Frequency of Wounds to the Back, Waist, and Buttocks by War Years.

The curve for the frequency of wounds to the upper extremities (Figure 12), as opposed to the previously given curves, shows a sharp reduction for the second year of the war and a significant decrease with each subsequent year. The average frequency of such wounds for the entire war is at the middle of the curve.

Thus, the frequency of wounds to the head, chest, abdomen, and lower extremities increased significantly from year to year, while that of wounds to the neck and spine hardly changed, that of wounds to the back, waist, and spine had dropped by the fourth year of the war and that of wounds to the upper extremities increased steadily and significantly.

In order to explain the causes of these phenomena, it is necessary to determine the nature of the wound, i.e., to take the wounding weapon into consideration, subdividing wounds into bullet and fragment wounds. It was shown above (Figure 4) that the frequency of fragment wounds increased from year to year, while that of bullet wounds decreased. Diagrams are given below which show

the frequency of fragment and bullet wounds according to site.

Wounds to the head from fragments (Figure 13) were observed significantly more frequently than bullet wounds, with the frequency of fragments wounds increasing from year to year and that of bullet wounds decreasing.

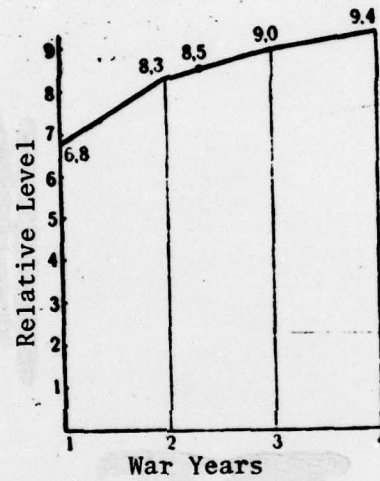


Figure 11. Comparative Frequency of Wounds to the Lower Extremities by War Years

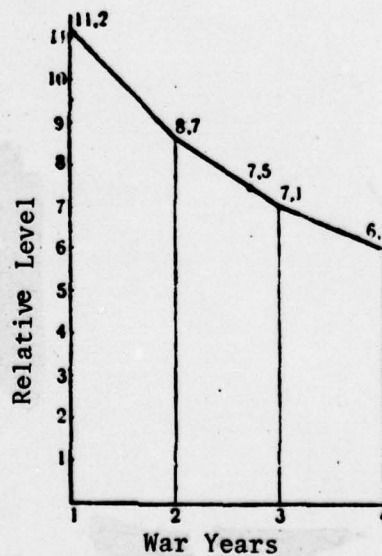


Figure 12. Comparative Frequency of Wounds to the Upper Extremities by War Years

[Commas indicate decimal points.]

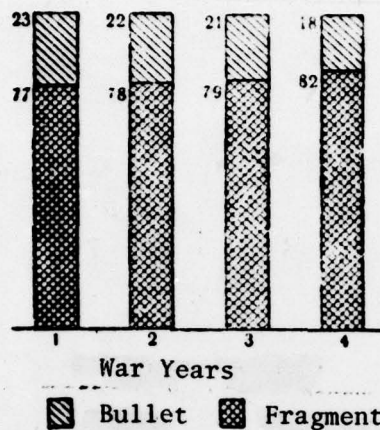


Figure 13. Ratio Between Bullet and Fragment Wounds to the Head by War Years

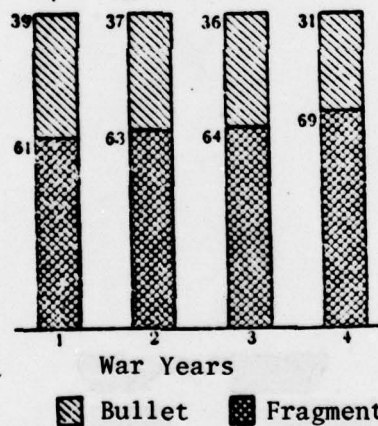


Figure 14. Ratio Between Bullet and Fragment Wounds to the Neck by War Years

The bars are of the same type for wounds to the neck (Figure 14), but the total number of bullet wounds is closer to the general number of fragment wounds.

The bars showing wounds to the chest (Figure 15) show an increase in the frequency of fragment wounds throughout the first three years of the war, while in the fourth year of the war the frequency of fragment wounds decreased slightly in comparison with the third year, and the frequency of bullet wounds increased.

In the second year of the war the number of fragment wounds to the abdomen (Figure 16) increased slightly in comparison with the first year, and in the third year it increased again. A slight reduction was noted in the fourth year.

The frequency of wounds to the spine (Figure 17) is generally constant and underwent significant variations. However, fragment wounds to the spine predominated.

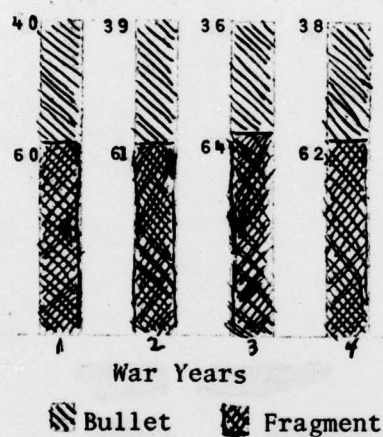


Figure 15. Ratio Between Bullet and Fragment Wounds to the Chest by War years

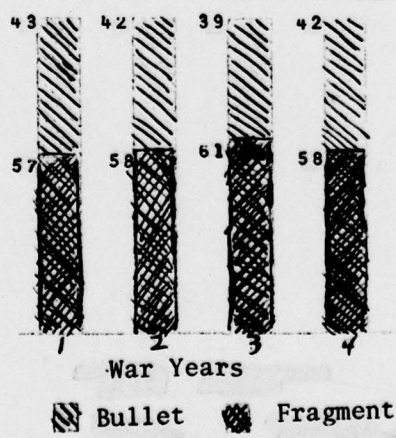


Figure 16. Ratio Between Bullet and Fragment Wounds to the Abdomen by War Years

The frequency of fragment wounds to the lower extremities (Figure 18) increased steadily; the frequency of bullet wounds decreased just as steadily from year to year.

The diagram of wounds to the upper extremities (Figure 19) presents a completely different picture. Primarily, during the first three years of the war a predominance of bullet wounds rather than fragment wounds, as for other wound sites, was noted. However, the frequency of fragment wounds increased with each year of the war, while the frequency of bullet wounds decreased, and fragment wounds in this area were already predominant by the fourth year of the war.

If we subtract the diagrams for injuries to the upper and lower extremities, i.e., the overwhelming majority of all military wounds, then it can be seen that the frequency of bullet wounds decreased with each year, while that of fragment wounds increased steadily. By the second year of the war, the frequencies of bullet and fragment wounds had become identical (1 : 1) (Figure 20).