Chapter 1

THE WEAPONS OF CONVENTIONAL LAND WARFARE

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INTRODUCTION

If, as Karl von Clausewitz said, "war is only a continuation of state policy by other means,"' then the nature of the "other means' '—the weapons of war and their use—becomes the essential subject matter for the military officer. Medical officers have traditionally ignored weaponry, perhaps believing either that such knowledge has no therapeutic benefit for the casualty or that it is in some way incompatible with their ethical obligations. Nevertheless, there are cogent **reasons** why medical officers should understand weapons and their effects:

- Knowledgeable medical officers will be better able to treat the casualties who are their patients. For example, surgeons who know that wounds made by bullets from high-velocity rifles frequently do not contain massive soft-tissue destruction may be less likely to debride excessively. Similarly, surgeons who know that bullets of a certain design tend to fragment in tissue will be alert to the probable need for extensive surgical exploration. An elementary knowledge of the design and construction of weapons may be useful in unexpected ways as well. For example, an American soldier was thought to have been deliberately shot by one of his own men during a firefight in Vietnam, but the presence of the radiopaque cylinder (typical of the steel core of a Russian-made M43 bullet fired from the Kalashnikova assault rifle) on his roentgenogram indicated that the wound resulted from enemy action (Figure 1-1).
- Medical officers are responsible for protecting the casualties in forward medical units in the combat zone. They will be better able to discharge this responsibility if they can effectively and safely use weapons.
- A surgeon may need to remove an unexploded munition lodged within a casualty's body, and an may not always be available to advise the physician how to proceed safely. What should be done, for example, to treat a casualty who has been struck by a projectile fired at close range and whose gaping soft-tissue wound contains a grenadelike foreign body?
- Medical officers need a knowledge of weapons and their effects in order to predict accurately the number and types of casualties that are likely to result from a combat action.
- The medical officer who is familiar with weapons effects will be more likely to recognize wounds caused by novel enemy **weapons.** Early in World War II, for example, Soviet military medical authorities recognized that a weapon of unusual design—later identified **as the** German-made Nebelwerfer, the earliest rocket artillery weapon-caused the distinctive pulmonary injury that is now recognized as *blast lung* (described in the blast section of this textbook.)
- An understanding of weapons effects can lead to the development of protective equipment. For example, Israeli medical officers helped to develop fireproof clothing and the Merkava tank to reduce the incidence of burns to tank crews.

The terminology used in weapons development reflects the relatively rapid development of this field. Words that had a particular meaning in the nineteenth century may now be used to refer to a modern munition that evolved from the original concept but may look nothing like its ancestors. The word *gun* is an example. In the broadest sense, a gun is any weapon that is closed at one end and ejects a projectile from the other. (Thus, by strict definition, what is now called a *recoilless gun* is not really a gun at all, because it is open at both ends.) Over the years, two families of weapons have come to be known by the civilian community as guns: *(a)* small arms and *(b)* heavy weapons used by artillery forces. These weapons operate by the same principles but differ vastly in size, objective, and specialized design refinements. The military community, however, uses the word very specifically to refer only to the heavy weapon, **and** this textbook will do the same.

Ammunition is defined as the various projectiles (together with their fuses, propellants, and primers) that are fired from firearms; *munition* means a material used in war for defense or attack. This chapter will discuss the three types of wounding agents that are most common in conventional warfare: *(a)* ammuni-

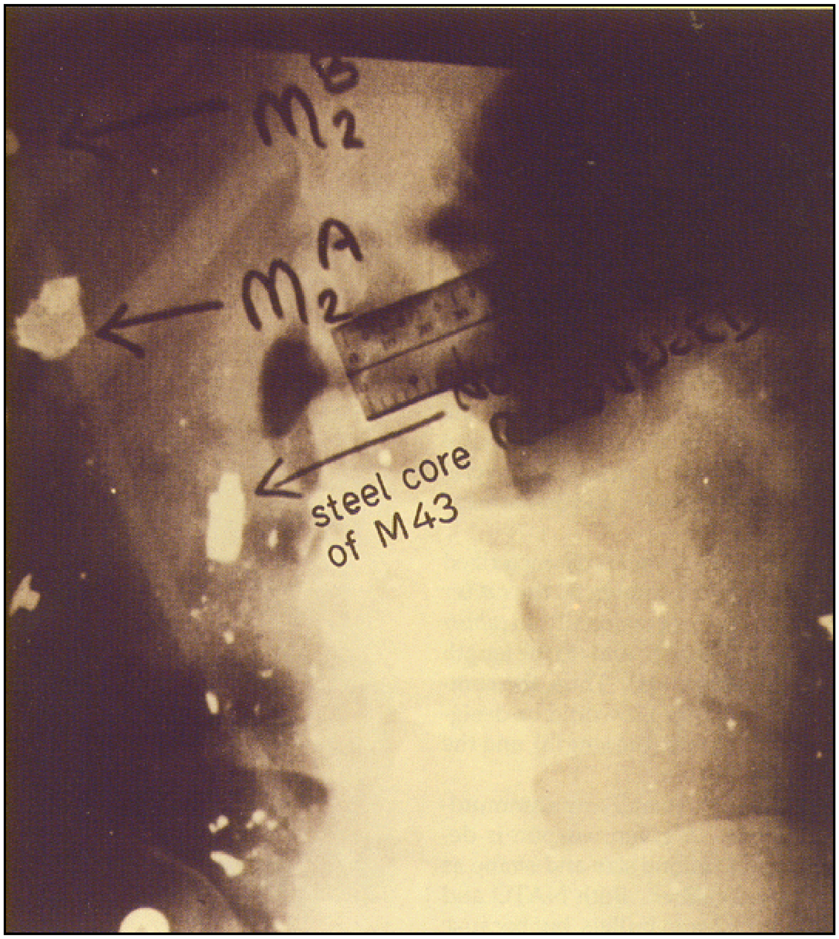

Fig. 1-1. The large metal cylinder shown in this abdominal roentgenogram is the soft steel core of a 7.62 x 39-mm round from a Kalashnikova assault rifle.
Source: Wound Data and Munitions Effectiveness Team

tion that is fired from small arms, *(b)* explosive munitions, and *(c)* flame and incendiary munitions. Because the first two categories of munitions not only cause most battlefield casualties but also present treatment problems that are not likely to be common in nonmilitary medical contexts, they will be discussed at some length in this chapter. The biophysics and the clinical implications of the effects of all three categories of munitions will be discussed in greater detail in this textbook's sections on ballistic, blast, and burn injuries.

Another term that is applied to both small-arms ammunition and heavy explosive munitions is *round.* A round is simply a unit of ammunition that is fired by a weapon. It comprises all of the parts that are necessary either to fire that one shot, or, if the ammunition is designed to do more than act as an inert projectile, to allow it also to travel through air and function successfully when it arrives at the target. Technically, a round can be as simple as one stone hurled from a slingshot. Given modern technology, however, rounds may be even more complex than the weapons that fire them. Depending on their designs, rounds might **include** any **number** of **refinements,** such as sophisticated fuses, fragmenting submunitions, flight stabilizers, tracking devices, or specialized propellants.

The terms *effective range* and *effective radius* are not interchangeable. In this text, the effective range of a weapon will refer specifically to the distance between the point at which the projectile is fired, thrown, or launched and the furthest point at which it can do damage to a certain percentage of combatants. (Depending on the munition, this may mean either a target or a detonation site.) The effective radius refers to the area around an explosive munition's detonation site within which a certain percentage of casualties can be expected.

CHARACTERISTICS OF SMALL ARMS

Small arms are weapons that are used by individual soldiers or small crews primarily to injure or kill enemy personnel.

Small-Arms Ammunition

Small arms fire solid projectiles that have diameters smaller than 20 mm. The typical round of small-arms ammunition consists of *(a)* the bullet and *(b)* the cartridge, which contains the propellant powder and primer and into which the bullet is inserted. Several factors are relevant to the description and assessment of small-arms ammunition.

Measurement. **A** complete round is characterized by *(a)* the diameter of the bullet, known as the *caliber* and measured in millimeters or, occasionally, in *caliber units* (one caliber equals 1/100 inch) and *(b)* the length of the cartridge (also in millimeters). Thus, the complete rifle round shown in Figure 1-2 would be designated as 5.56 (the caliber) x 45 mm (the length), and the pistol round would be 9 **x** 19 mm.

It is not sufficient to refer to small-arms ammunition by bullet caliber alone. **A** given weapon is designed to fire a cartridge of unique size and shape as well as a bullet of defined caliber. Both NATO and Warsaw Pact forces field 7.62-mm bullets, but because the cartridges are quite different, the rounds are not interchangeable.

Velocity. All other factors being equal, the larger the cartridge is (that is, the more it

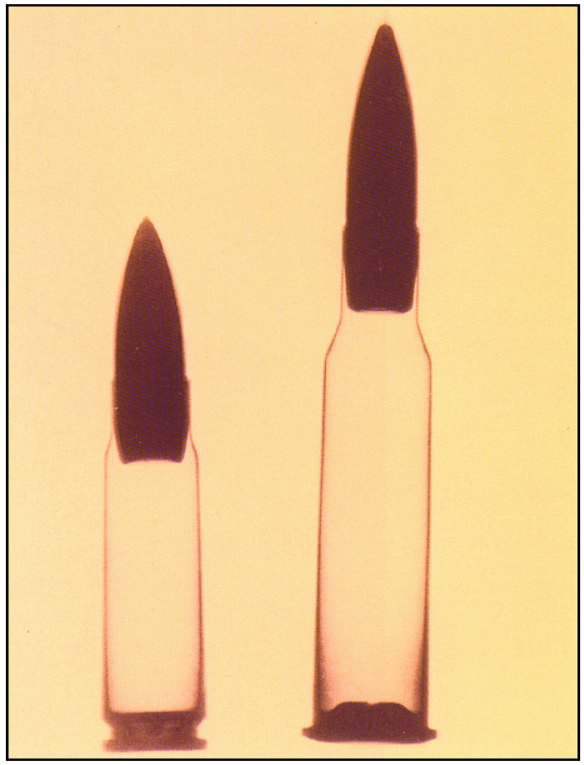

Fig. 1-3. The smaller **7.62 x** 39-mm round on the left was one of the first intermediate-power rounds to be developed during World War *II*, after the old full-power rounds (such as the 7.62 x on the to be unsuited to the fully automatic rifles then being developed. **Source.** P. M. Dougherty

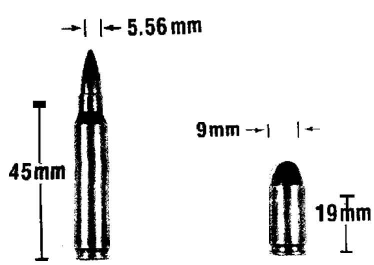

Fig. 1-2. The M193 round fired by an M16 assault rifle is on the left; the Parabellum round fired by the Beretta model M9 pistol is on the right.

contains), the higher the bullet velocity will tend to be at any given point on its path, and the greater its effective tactical range and penetration will be as well. Not surprisingly, the bullet from the rifle round shown in Figure 1-2 has an appreciably higher muzzle velocity (3,200 than does the bullet from the pistol round (1,100 fps).

Significant differences in velocities may exist even among rounds that have the same caliber bullets but different cartridges (Figure 1-3). When fired by the appropriate weapons, the bullet from the Soviet-made 7.62 x 39-mm round **has a** muzzle velocity of 2,350 fps, whereas the one-third larger cartridge of the Soviet-made 7.62 **x** 54R-mm round gives its bullet a muzzle velocity of about 2,850 fps. (The "R" signifies that the cartridge has a rim.)

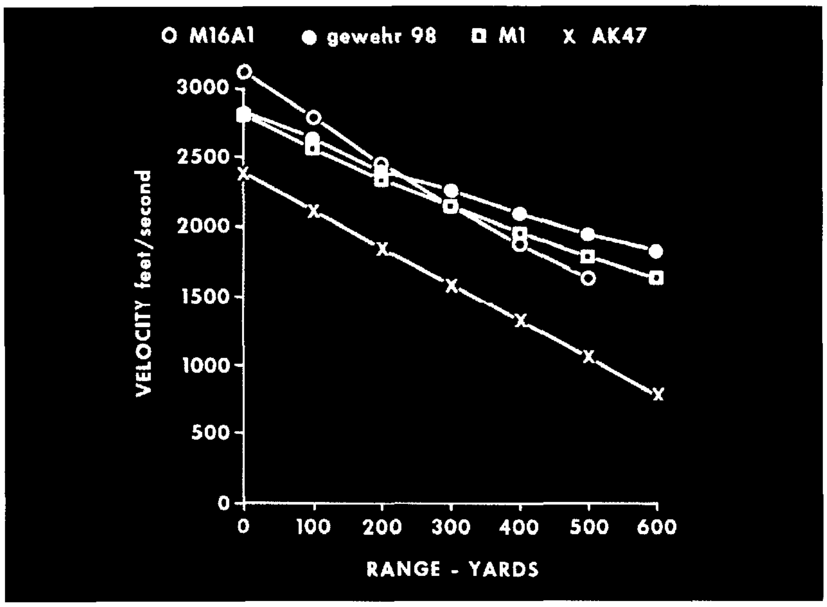

Fig. 1-4. Velocity as a function of muzzle distance for four military rifles: the German-made Gewehr 98 used in World War I (• • *), the American-made M1 used in World War II (■■■), the Soviet-made AK47 (x x x), and the American-made M1h (OOO).
Source: Data estimated by M. L. Fackler from reference 2

Tactical Conditions. How useful a particular round will be in combat depends on more than its velocity, however. For example, when it is used in an automatic weapon, the smaller, slower round shown in Figure 1-3 is more useful to the soldier. Not only can it be fired more accurately than the larger cartridge that it replaced, but the lighter weight of the new round also allows the soldier to carry as much as 50% more ammunition without increasing his load.

Because the velocity of the bullet in flight is related to its distance from the muzzle, tactical conditions determine the distances at which small arms are likely to be most effective (Figure 1-4).[2] An M16A1, for example, is designed to fire high-velocity bullets and to hit targets at a tactical distance of 500 m. On the other hand, an AK47 (the Russian-made Kalashnikova assault rifle) is usually used tactically to spray lower-velocity bullets over a wider area within a much closer range, about 50–100 m. Yet by the time the high-velocity M16 bullet reaches its designed tactical distance, it may actually be traveling more slowly than the lower-velocity AK47 bullet will be when the latter reaches the perimeter of its spray-gun range.

Military Objective. Depending on the objectives they are intended to achieve, even bullets that look alike may be quite different (Figure 1-5). The most common military bullet, known as *ball ammunition,* consists of a metal jacket filled with lead; it is designed to injure or kill personnel.

Specialty rounds have been designed to perform specific functions. The *tracer round* contains pyrotechnic chemicals that trace the flight of the bullet, a valuable aid to accuracy in combat. The *armor-piercing round* contains a dense metal rod within the bullet's jacket that is designed to penetrate soft-skin vehicles, such as trucks. When the bullet comes in contact with the vehicle, its jacket is peeled back and the exposed penetrating rod continues on through the target wall.

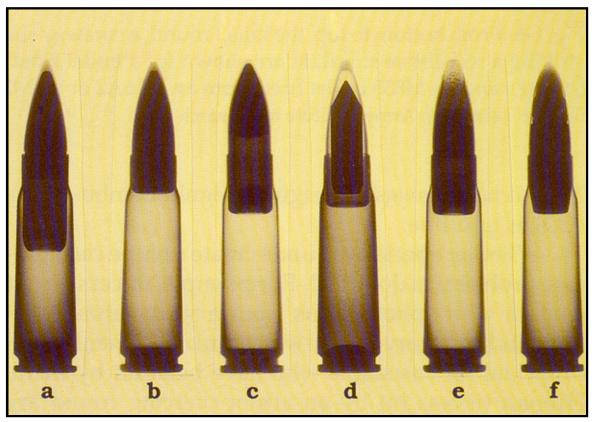

Fig. 1-5. All of the rounds shown in this roentgenogram have dimensions of 7.62 x 39 mm and are similar in appearance (except for their color coding, which cannot be seen on the roentgenogram): *(a)* a Soviet-made tracer-incendiary round; *(b)* a Yugoslavian-made ball-proof round; *(c)* a Soviet-made tracer round (note the metal cylinder, which contains the tracer material, at the bottom of the bullet); *(d)* a Finnish-made armor-piercing round; *(e)* a Soviet-made two-piece tracer-incendiary round; and *(f)* a Soviet-made armor-piercing incendiary round.
Source: P. M. Dougherty

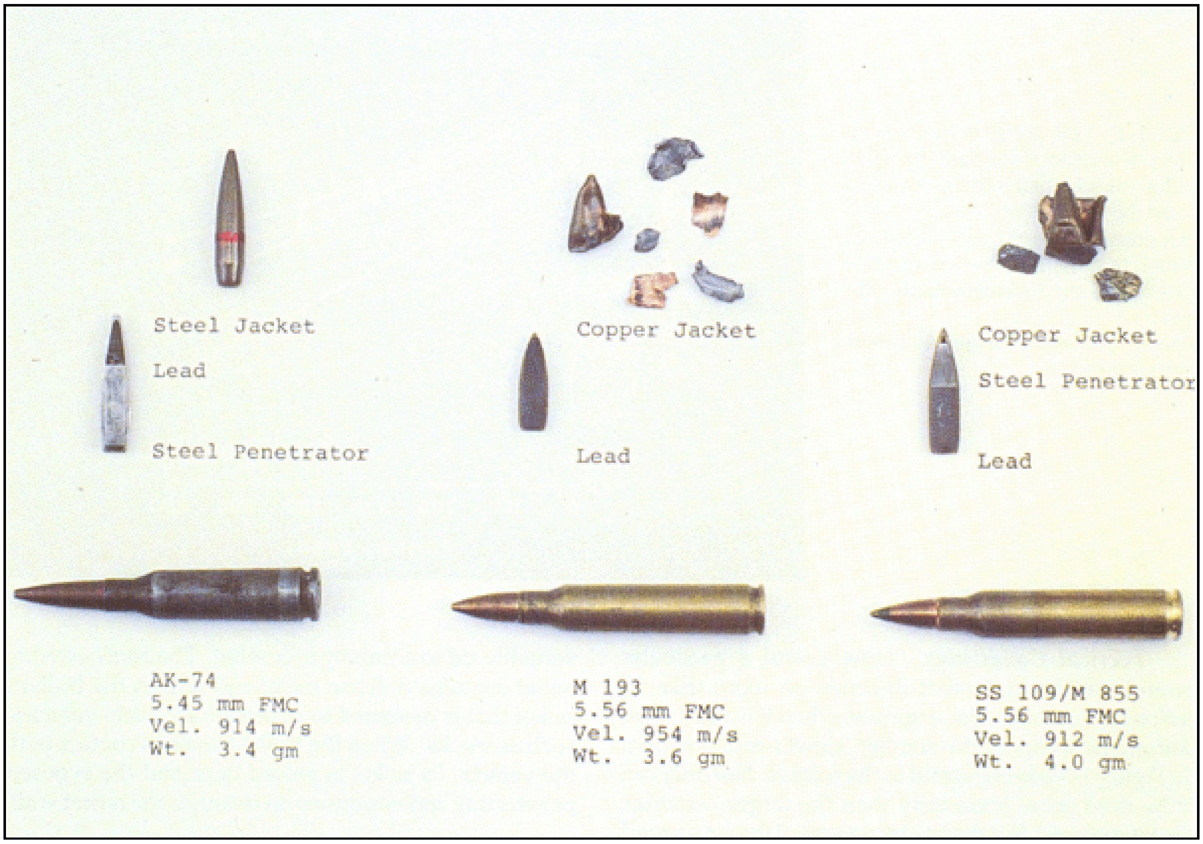

Fig. 1-6. From bottom to top, the intact round, a cutaway showing the internal construction, and the bullet as it appeared after striking a soft-tissue simulant are shown for a bullet fired from a Soviet AK74 (left), an M193 bullet fired from an M16A1 (center), and an M855 bullet fired from an M16A2 or an M249 Squad Automatic Weapon (SAW) (right).
Source: Letterman Army Institute of Research

The *incendiary round* is designed to ignite combustibles, such as gasoline.

Whether specialty rounds create unique casualty-care problems is doubtful. For example, tracers do not contain white phosphorus (contrary to common belief), and ordinary bullet-wound management is appropriate for casualties who have been hit by them. Human tissues hit by an armor-piercing round are usually not resistant enough to strip the jacket from the bullet and therefore the penetrating rod is not exposed. **Thcrc** is **no cvidcnce that incendiary rounds cause** unusual treatment problems.

Design* and *Construction. The bullet's design and construction determine the kind of wound that it will cause. The wounding effects of deforming hollow-point and soft-nose hunting ammunition are quite different from those of nondeforming bullets. The Hague Declaration of 1899 prohibited the use of any "bullet which expands or flattens easily in the human body."[3] To meet this requirement, bullets that are designed for military use must be completely covered by a metal jacket. Designers of military small arms have therefore used alternatives, such as fragmenting bullets, that cause equivalent tissue effects. In Figure 1-6, the two copper-jacketed bullets on the right have broken **up** into many small fragments, whereas the bullet on the left (which has a much stronger steel jacket) has neither broken up nor become deformed. The copper-jacketed bullets may cause more severe **tissue damage.**

Historical Development of Small Arms

Until the middle of the nineteenth century, soldiers relied on muzzle-loading smooth-bore muskets as their individual small arms. These weapons fired a solid spherical lead shot that traveled at low velocity and was not very accurate. The muskets were also difficult and dangerous to load: The soldier had to stand up to ram the shot down' a 3- or 4-foot-long barrel. The time that elapsed between the loading and the firing of the shot was several seconds, very slow by today's standards.

Single-shot Rifle. The introduction of the rifled musket and its spin-stabilized conoidal bullet (such as the Minie) in the 1850s may have had the greatest immediate and measurable impact on war of any new weapon before or since.' Modification of the rifle continued throughout the nineteenth century and led to such weapons as the Mauser Infanteriegewehr Model 1898—the Gewehr 98 (Figure 1-7)—a variant of which was Germany's standard rifle in World War I.

The Gewehr 98 was a heavy, cumbersome, single-shot, bolt-action rifle that fired a powerful 7.92 x 59-mm round. It was accurate well beyond 1,000 m in the hands of a well-trained soldier in the benign environment of the rifle range, although such an extensive range was rarely possible in battle. In the trenches of the western front of World War I, the performance of the Gewehr 98 and similar weapons proved to be less than optimal. There, the tactical mission was to saturate an enemy position at close range with overwhelming firepower. One weapon that performed this mission well was the *machinegun.*

Machine Gun. Like the single-shot rifle that it replaced in World War I, the machine gun fires full-power cartridges, but it is fully *automatic* (that is, while its trigger is depressed, it continues to fire until its ammunition supply is depleted). The largest and heaviest of all small arms, this weapon is *crew-served* (that is, it is operated by a team of two or three soldiers).

Machine guns are usually categorized as *(a)* light, *(b)* general purpose, or *(c)* heavy. Examples of Soviet-made machine guns and their ammunition in each category include the light RPK 74 (5.45x 39 mm); the general purpose RPK (7.62 x 39 mm) and PKS (7.62 x 54R mm) (Figure 1-8); and the heavy machine guns, like the 50-caliber NSV-12.7 (12.7 x 108 mm) and the KPV (14.5 **x 114** mm). The heavy machine guns are more often used against matériel; in fact, one of the

Fig. **1-7. The** Gewehr 98
Source: Presidio of San Francisco Army Museum

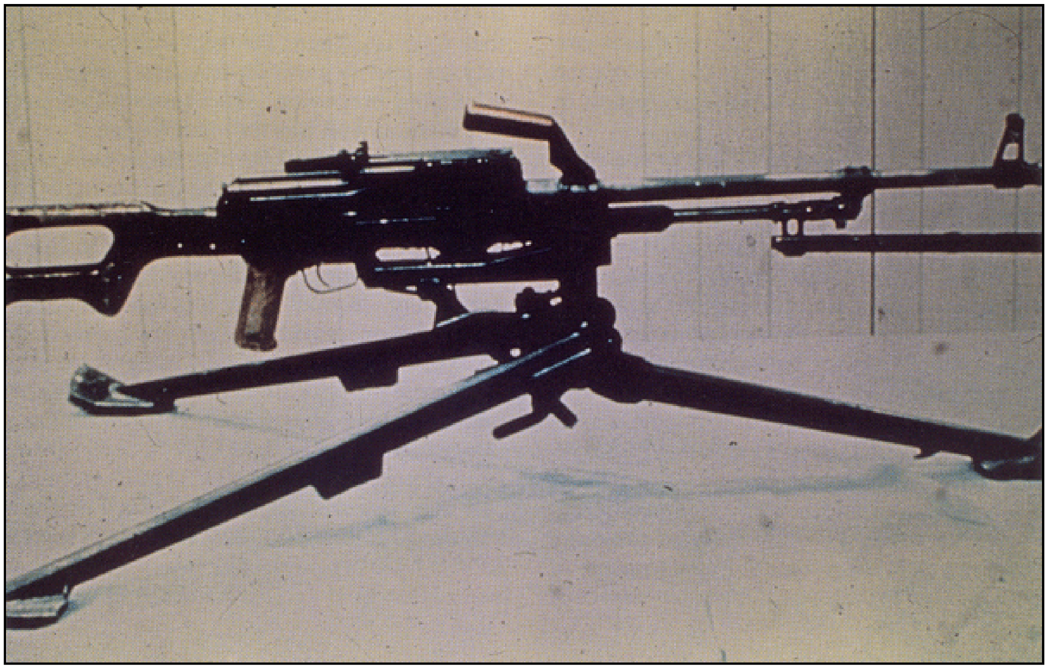

Fig. 1-8. The PKS is a general-purpose machine gun that weighs about 9 kg and has a cyclic rate of fire of 650 rounds/minute
Source: Letterman **Army** Institute of Research

Fig. 1-9. The Maschinenpistole 40 (Schmeisser)

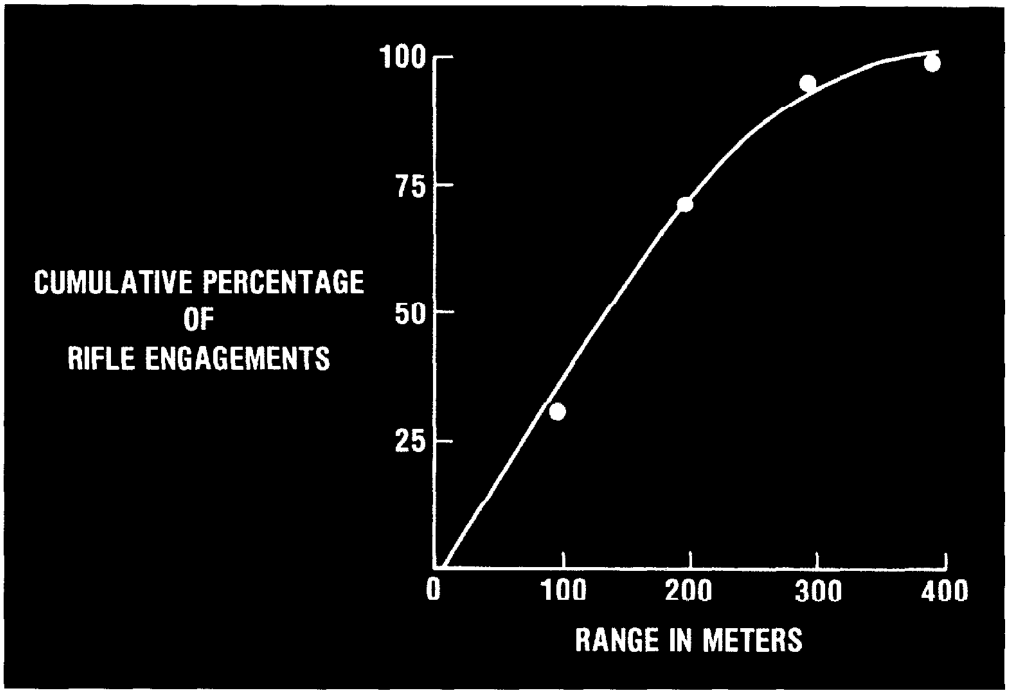

Fig. 1-10. The tactical distances for representative small-arms actions fought by American troops during and since World War II

Sources: Redrawn from **data in references 5 and 6**

design requirements for **M2 and** M3-series Bradley Fighting Vehicles was armor that could withstand the 60-g bullets fired by the KPV.

The relationship between the modern machine gun and the assault **rifle** (described below) is complementary. Like the assault rifle, the machine gun is used to suppress enemy fire rather than to hit specific targets. It is specifically used as a fixed base to provide fire cover for the maneuver elements who are armed with assault rifles. By virtue of its more robust construction and the better heat-dissipating properties of its barrel, the machine gun can sustain more prolonged fire with more powerful cartridges than the assault rifle can, but **its heaviness and large size, which make** it **so useful as** a fixed weapon, also create a burden for the soldiers who carry it.

Submachine Gun (Machine Pistol). The need for a lightweight equivalent of a machine gun was not met on a large scale until the appearance in World War II of the machine *pistol,* better known in English-speaking countries as the submachine gun. The classic example of this type of weapon is the Maschinenpistole 38/40, or, as it is better known, the Schmeisser (Figure 1-9). Unlike the single-shot rifle or the machine gun, both of which fired full-power cartridges, the submachine **gun fired pistol ammunition, which has much** less power, a short effective range, and lower lethality. Like the machine gun, however, its action was controllable and fully automatic.

Fully Automatic Rifle (Assault Rifle). The next step in the development of the soldier's individual weapon was the fully automatic rifle, but its design required ammunition that was intermediate in power between the old full-power round of the Gewehr **98** and the pistol ammunition used by the submachine gun. Gewehr 98 ammunition **could** not **be used** because—when even a single round was fired—its recoil was so violent that the weapon was difficult to control; **when used as a fully automatic weapon, only the first** shot was likely to be accurate. Nor was such power really necessary. As was the case in World War I, most ground actions involving small arms still tend to occur at distances of 200 m or less under most combat conditions (Figure 1-10).[5,6]

In 1943, the Germans developed an intermediate-power round measuring **7.92** x **29** mm by cutting the cartridge of the 7.92 x 59-mm round in two. This made possible the design of the first truly useful automatic rifle, the Sturmgewehr 44 (literally, assault rifle). At the same time, the Soviets developed an intermediate-power round with dimensions of 7.62 x 39 mm, and began to design a weapon similar to the Sturmgewehr. The result was the famous Avtomat Kalashnikova 1947g, better known as the AK47 (Figure 1-11), which was perfected after World War II.

The first American-made assault rifle, now known as the M16, appeared almost 15 years later. This weapon was not designed by the military; a civilian weapons designer based it on hunting ammunition that was commercially available at the time (the Remington 0.222-inch round modified to 5.56 x 45 mm). The army adopted the M16 after making certain modifications, some of which were later seen to be deleterious." The most important of these was to use more powerful powder, which, by increasing the cyclic rate of fire, also left more powder residue and increased the likelihood that the weapon would jam.

The assault rifle is now the infantry soldier's principal weapon. With its increasing use, military medical personnel have seen more casualties with multiple gunshot wounds sustained at a range of less than 100 m (Figures 1-12 and 1-13). In addition, the close range of the combatants means that first aid will have to be provided in the midst of the firefight, exposing the caregiver to mortal danger.

By combining the large-volume firepower of the submachine gun with the lethality and some of the range of the single-shot rifle, the assault rifle has made both of these weapons obsolete except for specialty missions. For example, the submachine gun is used by antiterrorist units (as well as by terrorists) because its small size makes it useful in confined spaces. Most armies continue to use the single-shot rifle as a sniper's weapon (Figure 1-14).

In addition to its more lethal ammunition, the assault rifle has a relatively long effective range of about 400 m (Figure 1-15).[7] However, it is more frequently used to suppress close-range enemy fire than to hit specific distant targets.

Pistol. The role of the pistol on the modern battlefield remains one of conjecture. Although pistols are issued to officers and specialists for personal defense, they have a very short effective range, fire a bullet of modest lethality, and thus are infrequently used. Military personnel who want a truly effective personal weapon are more likely to opt for an assault rifle, a submachine gun, or even a shotgun.

The planned replacement of the venerable Colt .45 (which has a 250-grain, 800-fps bullet) with the Beretta M9 (which has a 115-grain, 1,100-fps bullet) is sure to

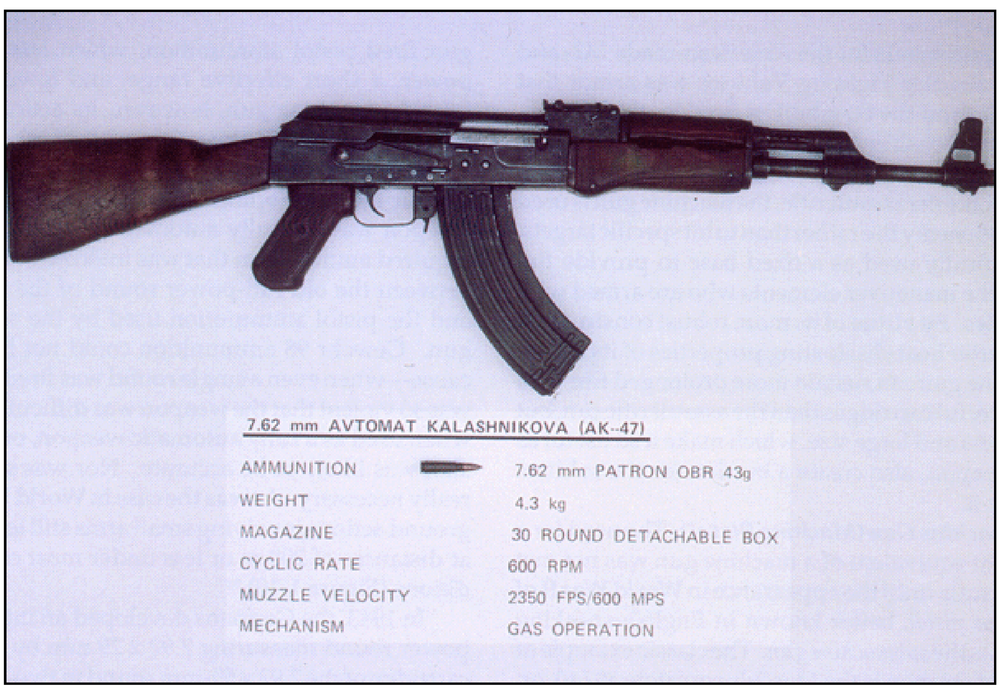

Fig. 1-11. The **AK47**
Source: Letterman Army Institute of Research