The US Army War College Quarterly: Parameters

Volume 25
Number 1 *Parameters 1995*

Article 36

7-4-1995

Dealing Realistically With Fratricide

Kenneth K. Steinweg

Dealing Realistically With Fratricide

KENNETH K. STEINWEG

From *Parameters*, Spring 1995, pp. 4-29.

The tragic downing of two US Army helicopters over Iraq by two US Air Force jets in April 1994 once again pushed fratricide into the national spotlight. The intense public scrutiny over the 17-percent fratricide rate in the Persian Gulf War was just subsiding when this reminder appeared. As demonstrated by this most recent incident, fratricide is a multi-service, joint problem. For those hoping the problem will go away, it will not.

Some sources suggest that the high fratricide rate of the Persian Gulf War is a new phenomenon, attributable to the lethality and technology of the weapons of modern war.[1] Others state that the Persian Gulf War rates were due to the time available for combat seasoning, "which invariably reduces the frequency of friendly fire."[2] These arguments overstate the cause and understate the issue. Fratricide is such a sensitive topic that few people have attempted to study it, and only recently is it being portrayed as an issue that might be confronted with the intention of developing solutions to reduce its awful cost. Its deep psychological and cultural aspects and the fog of war associated with fratricide have made it, until recent times, something of a pariah.

This article identifies and analyzes several controversies related to fratricide: how to define it, how to calculate it, and how to present the results. Case studies used in the analysis--from all major 20th-century conflicts--strongly suggest that fratricide rates have been *at least five times greater* than the generally accepted rate of two percent. The experience at our national training centers and the training technologies in use there support this historical evidence. Four decades of behavioral research help to explain why our fratricide rates have always been so high and why they resist efforts to reduce them. Finally, emerging weapons, frequent involvement in joint and coalition warfare, and the expected conditions of the future battlefield can only aggravate present fratricide rates. New initiatives are required to prevent any increase in the fratricide rate and to reduce that rate from its historical norm. That conclusion has significant implications for policy, doctrine, and fratricide prevention techniques and technologies that will affect all of the military services.

Fratricide: Definition and Calculation Controversies

Any purposeful discussion of fratricide must first settle the issue of its definition. At first glance, the definition would seem obvious: the wounding of a soldier by his own troops. Examples suggest that we need a more rigorous definition, one that excludes weapon malfunctions, weapon cleaning accidents, and deliberate self and friendly wounding, all of which have been included in combat casualty data in the past. The recently adopted US Army Training and Doctrine Command (TRADOC) definition narrows the conditions for inclusion under the heading of fratricide:

> Fratricide is the employment of friendly weapons and munitions with the intent to kill the enemy or destroy his equipment or facilities, which results in unforeseen and unintentional death or injury to friendly personnel.[3]

The qualification in this definition that makes it so restrictive is the portion "with the intent to kill the enemy or destroy his equipment or facilities." These words eliminate accidental weapon explosions and misfires, training accidents, and self-wounding of any kind, whether intentional or not.

An unexpected controversy, little appreciated by the lay public and difficult for all to understand, is the method of presenting fratricide information. What follows is a complex but necessary discussion of the three ways in which fratricide rates are calculated. They are not directly comparable methods. Often the methods are intermixed or used interchangeably with no clear notation of method, further complicating a problem that is inherently difficult to understand.

The first method, a ratio between two groups of friendly casualties, is the traditional formula for fratricide calculation:

$$\frac{\text{number of friendly troop casualties caused by friendly fire}}{\text{total number of friendly casualties}}$$

This is the conventional method; it is used in all historical examples to be presented here. Yet it can be misleading. If friendly soldiers are efficient at dispatching the enemy with few casualties from the enemy, fratricide as a percentage of total friendly casualties would be high. This reason is given as one explanation for the Persian Gulf War rate. This method of fratricide calculation is used at the Joint Readiness Training Center (JRTC) at Fort Polk, Louisiana.

The definition of fratricide states that the friendly troops must be injured while trying to inflict injury on the enemy. Therefore, some sources argue, a more accurate and fair way of depicting fratricide is to reflect enemy casualties in the denominator of the equation.[4] This results in the following formula:

$$\frac{\text{number of friendly troop casualties caused by friendly fire}}{\text{total number of } \textit{enemy} \text{ casualties inflicted}}$$

The advantage of using this second method is that it relates the effectiveness of inflicting enemy casualties to the mistakes of wounding a friendly soldier. When well-trained soldiers and brilliant strategy inflict huge losses on the enemy, we would see very low percentages of fratricide. A slightly modified version of this method is used at the National Training Center (NTC) at Fort Irwin, California.

There are substantial difficulties with this method of calculation in combat operations. Obtaining enemy casualty data for the same time period as friendly fire data was collected is extremely difficult given the nature of war itself and some of our opponents since WWII: Chinese, North Koreans, North Vietnamese, Viet Cong, Iraqis. Several attempts were made to compile enemy and friendly casualties for the same battle or time period during the Korean War. One study over a 60-day period is marked by ambiguity, missing data, and assumptions, all of which contribute to estimates of casualty ratios between enemy and friendly forces that fluctuate wildly between 3:1 and 1:1.[5] A second detailed Korean War study (370 pages and covering a single battle over a period of one month of combat) gathered all available information on opposing sides. Called a "limited vertical slice of combat" and with many adjustments for missing and contradictory data, this study derived enemy to friendly casualty ratios of 2:1 to 2.5:1.[6] This source makes no reference to fratricide, in spite of extensive information on casualties, which makes any conclusion for this discussion suspect.

Just as important, if one uses this second method of calculation, not every enemy casualty should be counted. In an example related to the Persian Gulf War, if the Iraqis suffered 100,000 casualties, American fratricide rates would be a fraction of a percent. But is it accurate to count all enemy casualties in the denominator or only those who were at risk from the soldiers they faced? An Iraqi soldier 200 miles to the rear of his front line and under attack by the Air Force is not a target engaged by American ground soldiers. This enemy should not be part of the denominator in the new equation. Deciding which enemy casualties were at risk and should be included in the denominator makes this second method of calculation very difficult.

Finally, there is a third method of presenting fratricide data: raw total numbers with no denominator. Whereas the first method discussed relates fratricides to total friendly killed and wounded, and the second relates them to enemy killed and wounded, this third method uses total numbers of US soldier casualties caused by friendly fire, period. The number stands out starkly in a one-to-one ratio with human life. Air Force fratricide cases are often presented this way. The Combat Maneuver Training Center (CMTC) in Hohenfels, Germany, uses this method of fratricide data presentation.

The three methods are summarized in Table 1.

	Method 1	***Method 2***	***Method 3***
Numerator	Friendly Casualties by Friendly Fire	Friendly Casualties by Friendly Fire	Friendly Casualties by Friendly Fire

Denominator	Total Friendly Casualties	Total Enemy Casualties	No Denominator
Training Center Using Method	Joint Readiness Training Center	National Training Center	Combat Maneuver Training Center

Table 1. Methods of Fratricide Calculation

Careful attention must be paid to the method used to present fratricide information before trying to apply the results to policy and doctrine. It is important to understand in reading the following case studies that mixing different methods of fratricide calculation produces comparisons based on entirely different logic and emphasis.

Case Studies

The most comprehensive compilation of fratricide examples and cases was published in a landmark study by then-Lieutenant Colonel Charles R. Shrader in 1982. His examination of 269 different incidents acknowledges the difficulty of developing accurate rates but concludes, "It appears that amicicide [fratricide] incidents account for something less that 2 percent of all casualties in battle."[7] He repeats this assessment a decade later: "There are sound reasons to consider two percent of total casualties as a good working order of magnitude for amicicidal casualties, but as many critics have pointed out, the true number may be much higher."[8] Citing no reference for the figure, Trevor Dupuy states in his 1990 book on attrition and battle casualties, "There are no accurate statistics for fratricide. . . . The average proportions [are] more likely no more than 2 percent of casualties incurred."[9] Against this background the Persian Gulf War fratricide data look terrible. Is this latest fratricide rate really so inconsistent with historical precedents?

Before reviewing 20th-century case studies, we should note that a number of factors make analysis difficult. First, estimates of fratricide rates from official records are hard to find. Although battlefield fratricide has been known for centuries, there was no clearly defined reporting requirement prior to publication of the 1985 edition of AR 600-10, *The Army Casualty System*.[10] The TRADOC definition discussed above was not published until 1991. The edition of AR 600-10 used during the Vietnam War resulted in friendly casualties being classified either as "Killed in Action" or "Result of Hostile Fire."[11]

Second, there is a powerful bias against officially reporting fratricide in war. It is such a sensitive topic that few people have attempted to study it, and until very recently, no one has systematically looked at the issue. The assumption that fratricide is a rare event reinforced these biases. The Persian Gulf War exposed the magnitude of the issue.

Third, the confusion of battle and the difficulty of actually knowing what happened in combat means that what little data are available probably understate the case. This is particularly so in close man-to-man fighting and close artillery support. In most official records, for example, all wounds are attributed to the enemy.

Fourth, the collection and recording of casualty data initially take place at medical facilities, usually far from the place of injury, and without benefit of questions regarding source of injury. In reality, however, casualty data collection and reporting are Adjutant General (AG) functions and so the data are usually reported as gross numbers and totals which are generally devoid of clinical or causative details except for such categories as "bullet wounds," "shrapnel," "mines," or in the case of World War I, "gas." In addition, these AG reports are usually compiled from other reports, not derived from actual patient contact. Facts and issues not collected and explored early in the casualty evacuation process can never be developed after the fact. Only in smaller unit reports or unofficial individual records will such evidence be available.

Fifth, the myriad sources where fratricide might be discovered result in comparisons of different types of data. Personal memoirs on one hand may be the best source available in one battle, while occasionally battle reports or special studies may allude to the issue and allow one to draw some conclusions. By necessity, a variety of types of data must be used when studying fratricide. Any combat example will involve only a very small percentage of casualties incurred in the war. By themselves they tell a compelling story, and some can be generalized on a much larger scale.

Last, representative battles and campaigns, rather than well-known worst-case examples, must be examined if the

conclusions are to be considered representative of the persistence of fratricide. Worst-case examples are plentiful enough, only one of which will be mentioned below to demonstrate a point. The circumstances used in each of the following analyses will be explained so that the veracity of the information presented can be judged. There is nothing about the examples discussed, with the aforementioned exception, to think they lie outside the range of ordinary battlefield occurrences.

The search for data begins with one of the first conflicts of the 20th century: the Mexican Punitive Expedition in 1916-1917 to track down Pancho Villa. This conflict was small, involving on average approximately 8300 troops, and lacking in large-scale clashes. The Army Medical Department did classify injuries by disease and method of injury.[12] Of the data on casualties published by the Surgeon General's Office, "number [of friendly troops] shot by guard" is recorded as "4/1000." The casualty rate, dead and wounded, is recorded as 41/1000, which yields a ten-percent fratricide rate (4/41) using method one (friendly troops wounded by friendly fire, divided by total friendly casualties). The resulting fratricide rate does not include artillery fire, perhaps the most frequent cause of friendly fire casualties. Because the Punitive Expedition was characterized by small skirmishes, artillery was rarely employed in support of the infantry or cavalry. The fratricide associated with this expedition begins to establish the basis for challenging old assumptions.

World War I presents tremendous problems for research into fratricide. Early casualties incurred by American forces were so numerous and came so quickly that data overwhelmed the casualty collecting system then in place.[13] The meticulous categories used in the Mexican Punitive Expedition were abandoned; thousands of gas, machine gun, and artillery casualties became mixed in with the figures on rampant diseases. More than 10,000 medical records were lost. Only the grossest of casualty types are reported. It is in this kind of chaotic environment that personally kept records may give the best insight.

The personal records of a Regimental Aid Station physician, Dr. L. D. Besecker (23d Infantry Regiment, 2d Infantry Division), during March-June 1918, are very instructive. Each patient treated was meticulously recorded by name, identification number, description of wounds, status, evacuation data, and agent of wounding. It is here that Dr. Besecker carefully documented wounds by friendly fire. Of the 82 combat casualties identified during this period, at least eight (ten percent) were caused by friendly fire. The 2d Division had arrived in France in late 1917 and trained extensively before entering the lines in March 1918. The abrupt ending of the log in June 1918 coincides with the start of a large German offensive against the 2d Division and probably reflects the fact that the author was overwhelmed by sheer volume of patients.[14]

Following World War I, French General Alexandre Percin alleged in his book *Le Massacre de notre Infanterie* that 75,000 of France's 3.3 million casualties were due to artillery fratricide.[15] He derived a 2.2 percent fratricide rate from a medical study at the beginning of the war, which he indicated was obviously too low. "I am certainly far below the reality [artillery fratricide rate] while the incidents involving heavy artillery--Verdun clearly showed this--were far more numerous once trench warfare was established."[16] General Percin cites numerous examples with higher rates in the appendix of his book, including one study revealing that two out of every ten shells that fell on the trenches were from friendly artillery. General Percin appears to endorse this estimate of 20 percent of all artillery casualties being from fratricide, proposed by a French general he considered "sympathetic" to the artillery. Yet many have used General Percin's earlier-cited 2.2-percent figure as a properly calculated number of artillery fratricide and one that he supported. Such is obviously not the case.

The British had similar problems with artillery fratricide that were also related to tactics: "The `creeper' [rolling barrage] covered the ground progressively in front of and behind the objectives. All the infantry had to do was to stay close to it [the artillery barrage] even if the occasional short round sprayed them with shrapnel."[17]

Dr. Besecker, in his earlier account, did not attempt to sort out friendly from enemy artillery injuries, the common problem alluded to by General Percin. Given the fact that American troops trained extensively with the French prior to commitment to the front and initially were assigned piecemeal among French units, there is good reason to believe that American units also suffered from artillery fratricide. To the extent that the foregoing is correct, Dr. Besecker's data on fratricide represents a low estimate of the actual total.

The duration of World War II, and the extent of American involvement in it, provided many opportunities for obtaining new data on fratricide. Medical reports do in fact reveal excellent, well-documented evidence of the full scope of fratricide injuries. The examples below from this war are by-products of information collected for other reasons, but in each case they shed light on fratricide because the right questions were asked.

Captain James Hopkins was a battalion surgeon with the 5307th Composite Unit (Provisional), often referred to as "Merrill's Marauders." He served in campaigns on New Georgia Island and in North Burma. During periods in both of these campaigns, and because of his personal interest in the value of body armor, he meticulously recorded the mechanism and method of injuries of each individual soldier as they occurred. Lines of casualty evacuation required that the wounded and dead pass through Hopkins' aid station, where he had personal contact with the patients. Consequently his records are unusually complete and, because of his interest and medical training, unusually accurate. He interviewed patients or other soldiers from the same unit about each casualty. He published individual surveys of both campaigns in 1962. The New Georgia campaign surveyed 161 casualties and the Burma campaign 202. Hopkins' data identify friendly fire as causing between 13 and 14 percent of the casualties in both the Burma and New Georgia campaigns, when corrected for the TRADOC definition of fratricide.[18]

Another World War II example, also from the Pacific, was the product of a dedicated and well-supported study of combat casualties. A team composed of physicians, ordnance staff, and technicians carefully studied every casualty as it occurred in what is referred to as the Bougainville Study in the Solomon Islands. Autopsies were performed on those killed. The 1788 casualties incurred by the two divisions in this campaign were catalogued from February to April 1944: 16 percent of the killed in action (KIA) and 12 percent of the wounded in action (WIA) were attributed to friendly fire.[19] Strange as it may seem, the author used the Bougainville data to compare and contrast actual lethality of US weapons on American casualties (219) versus Japanese weapons on American casualties (1569).[20] There was no discussion, and seemingly no analysis, of the high incidence of fratricide.

These carefully collected World War II studies build on the anecdotal and small data base of the earlier conflicts. Collectively they introduce the notion that the issue of fratricide, when carefully monitored, is a much larger problem than previously appreciated. Before going on to the Korean conflict, a final and vivid example from World War II makes the assertion of much higher fratricide rates even more plausible. Although it involved inexperienced troops, the example speaks for itself.

Expecting tough Japanese resistance, 35,000 US and Canadian troops invaded Kiska, an Aleutian island, in August 1943. The daylight assault was complicated by dense fog, and fighting continued through the night. By the end of the fight a day later, 28 men were dead and 50 were wounded. *There were no Japanese on the island*.[21] This catastrophic "battle" continued for 24 hours against an enemy who wasn't there. Thus 100 percent of the casualties were fratricide. The miscalculation, misidentification, and error in this assault clearly exemplify what the conditions of combat, fear, and uncertainty can do to judgment. The Kiska Island experience suggests that fratricide rates five or more times higher than the often-cited two percent are both understandable and reasonable in difficult, long-running combat operations.

The Korean War yields little data on fratricide rates in spite of voluminous records and reports of casualties. One reason for the dearth of such information can be found in the extensive use of US weapons by the North Korean army and Chinese Communist Forces (CCF). It was reported that whole units of the CCF were armed with the M1 carbine as well as the 1903 Springfield rifle;[22] the weapons came from US forces, or forces armed by the United States, as well as from Chinese arsenals. The forces of both nations also routinely used US-made machine guns and submachine guns. Type of ordnance therefore could not be used with any probability of accuracy to indicate whether friend or foe fired the wounding agent.

A dedicated Wound Ballistics Research Team was dispatched to Korea in late 1950 to do a careful survey, but they arrived just after the entry of the Chinese into the war. The team was denied country entrance and so set up a study of casualties in Japan. After stabilization of the Korean front, several members of the team did manage to survey some casualties in Korea. The report of this Wound Ballistics Research Team is devoid of any comment on fratricide. One photo included in the report shows 12 bullets removed from US casualties, six of which are of US caliber.[23]

Early mainframe computers were put to work analyzing Korean War casualty data. Most official studies were done after the war; these studies produced 119,000 IBM punch cards on which casualty data were recorded. Because of the limited abilities of the computers, collection was confined to only 50 fields of data per casualty. Answers about causative agents were punched in as either small arms, fragments, or other general munitions categories.[24] Thus the introduction of computer-assisted documentation did not materially influence our understanding of fratricide in that war. Because the right questions were never asked, pertinent data were not recorded in the casualty treatment and evacuation process.

Where fratricide does surface in Korean War reports, the issue is not discussed in detail. A limited study on the 25th Infantry Division during 26-31 July 1950, using casualty data computer cards, could ascertain the weapon responsible for the injury in only 47 percent of the cases. Within this study, the analysis of one regiment's casualties from bullets identified three of 44 casualties (6.8 percent) as from "friendly pistol, rifle." There is no subsequent discussion of this category anywhere in the report. As it represents only one type of fratricide, from bullets, and does not deal with the historically more common cause, artillery, the overall rate is undoubtedly higher.[25]

The Vietnam War produced considerable data on combat deaths and injuries, largely because of a detailed survey conducted between 1967 and 1969, *during* the war and *in* Vietnam. Involving over 125 personnel and called *Evaluation of Wounds Data and Munitions Effectiveness in Vietnam*, the WDMET Study was a dedicated and well-supported effort that studied more than 7800 casualties during this two-year period. It was a massive undertaking, with data collected case by case as casualties occurred. Each case was thoroughly documented, to include interviews when possible, with photographs and meticulous searches for wounding agents and their identification. Intended to study weapon lethality, body armor protection, and medical treatment requirements, the WDMET Study integrated the work of many branches of the Army; ordnance, artillery, infantry, and medical personnel all played major roles.[26]

In the study's comprehensive three-volume report are casualty data on 5993 cases in one survey, with a separate survey of 500 consecutive autopsy cases. Extensive information on the causative wounding agent was carefully collected in many of the reported cases. In the autopsy series, tables summarize data by type of missile. Of the 161 autopsied fatalities due to identifiable bullets, 22 fatalities (13.7 percent) were from 5.56mm M193 (M-16 rifle) bullets.[27] Analysis of the 186 fatalities caused by fragments in this autopsy series reveal that at least 20 of the deaths (10.8 percent) were caused by US weapons. This figure assumes that all identifiable mortar and grenade wounds could be considered to have been caused by enemy weapons, which is a doubtful premise. A tally of the weapons responsible for the 5993 casualties shows four US weapon types--M-16 rifle, M-79 grenade launcher, Claymore mine, and artillery--responsible for 11 percent of all the US casualties.[28]

As straightforward as these data may seem, they are still open to challenge. The Viet Cong captured and used some American weapons, including the M-16, therefore casting doubt on who actually fired the weapons in these cases. A companion study in WDMET done by the Armed Forces Institute of Pathology carefully evaluated 56 KIAs by specific bullet type to study lethality and ballistic characteristics. Included in this group were 11 killed by M-16 rounds. Four of these are recorded as having been killed by friendly fire, four more by "circumstances unknown," two simply as "KIA," and one by "enemy sniper."[29] Although a small number of documented instances, the acknowledgment of at least four fratricides in the group, and the ambiguity surrounding many of the rest, leave open to question whether some or any of these deaths were caused by M-16s in enemy hands.

Additional evidence of high fratricide rates in Vietnam appeared recently in Charles Hawkins' careful review of his infantry battalion's 1970 tactical operations center journals. A review of four months of low- and mid-intensity combat revealed an average fratricide rate of 14 percent. No single weapon system was dominant. Fratricide occurred across the spectrum of weapons: artillery, mortars, rifles, and close air support.[30]

Operation Just Cause, conducted in Panama late in December 1989, lasted only a few days and was characterized by night operations and small infantry tactics. Evidence from Panama buttresses all the previous data and interpretations. Three of the 23 killed in action were fratricide victims. Of the 310 wounded, estimates of wounds by friendly fire vary from a minimum of 16 to the more likely total of 37. The original 16 WIA identified as friendly fire casualties were scattered about the country in several incidents. An additional 21 occurred in one incident in which troops on the ground were misidentified by an AC-130 gunship. Operation Just Cause therefore produced a fratricide rate of 13

percent among the KIAs, and between five and 12 percent of the WIAs.[31]

Table 2 summarizes the case histories reviewed. In every case the fratricide rate is many times higher than the two percent that appears repeatedly in print as the expected rate.

Conflict	*Source of Data*	***Fratricide Rate*** (Method 1, TRADOC Definition)
World War I	Besecker Diary (Europe)	10% Wounded in Action
World War II	Hopkins, New Georgia Burma Bougainville Study	14% Total Casualties 14% Total Casualties 12% Wounded in Action 16% Killed in Action
Korea	25th Infantry Division	7% Casualties
Vietnam	WEDMT (autopsy) WEDMT (autopsy) WEDMT Hawkins	14% Killed in Action (rifle) 11% Killed in Action (fragments) 11% Casualties 14% Casualties
Just Cause	US Department of Defense	5-12% Wounded in Action 13% Killed in Action
Desert Storm	US Department of Defense	15% Wounded in Action 24% Killed in Action

Table 2. Fratricide Rates in this Century's Conflicts.

Some surveys presented can be challenged in some respect. The World War II, Just Cause, and Persian Gulf War data are the most useful because they are the most complete. As a whole, the surveys demonstrate consistency in a fratricide rate that is many times higher than the earlier two percent estimate. Support for this much higher rate comes surprisingly from two other sources: training center data and behavioral research.

Training Center Data

Warning signs about our impending fratricide problem have been up for some time. In addition to the historical cases recounted above, the sophisticated monitoring technology at our three national training centers indicates the magnitude of the problem. These centers are the National Training Center (NTC) at Fort Irwin, California, the Joint Readiness Training Center (JRTC) now at Fort Polk, Louisiana, and the Combat Maneuver Training Center (CMTC) at Hohenfels, Germany. Data on fratricide have been collected at the NTC and JRTC since 1985, and at the last center, CMTC, since it was opened in 1989. Human controllers, computers, and technological innovations that support and add realism to training, including the use of MILES (Multiple Integrated Laser Engagement System) equipment, at these training centers permit the careful collection and study of fratricide data, causes, and rates.

At the desert training area at NTC, armor and mechanized units maneuver over vast expanses of flat terrain where visual line of site is often good. Direct fire weapons (tanks, infantry fighting vehicles) that allow visual identification of their target are used extensively here. As units oppose each other in mock battles, information is collected on shots fired, by whom and at whom. Special computerized equipment on each combat vehicle records the identity of the firer and the identity of the target, creating what is called matched pairs (the firer paired with the target). Since the technology differentiates between friendly and opposing vehicles, equipment, and personnel in each recorded instance, high volumes of data have been made available for analysis. It is unlikely we can get any better at tracking weapon fires and identifying "casualties."

The Center for Army Lessons Learned (CALL) and the Army Research Institute (ARI) conducted detailed studies of direct fire records collected at the NTC from 1986 to 1990.[32] NTC reports fratricide as a ratio of shots fired at friendly forces by friendly troops, divided by total shots fired, a modification of the second method of calculating

fratricide (see Table 1). Fratricidal incidents there ranged from 5.6 percent of fires for defense in sector to 25.4 percent for deliberate attacks. The average fratricide rate for all types of maneuvers was 11 percent. To an offensively oriented Army, these represent huge potential losses.

These data are not directly comparable to one of the three commonly used methods of estimating fratricide discussed earlier. They can, however, readily be converted to method two, the most meaningful method of fratricide calculation: the number of friendly troops made casualty by friendly fire, divided by total enemy casualties inflicted. If 11 percent is the average accidental firing rate at friendly forces, then the other 89 percent are correctly aimed at the enemy. The ratio of fires at friendly forces to enemy forces is thus 11/89 or 12.4 percent. It must be remembered that although NTC simulates battlefield conditions in many realistic ways, it is not real battle with the additional anxiety of potential death. In addition, each unit operates for several weeks as opposed to longer periods of operations frequently encountered in combat. These battle figures also incorporate the additional advantage that units undergoing training at the NTC are fully aware that fratricide data are being collected and analyzed. A conscious, deliberate, and vigorous program to keep these losses at a minimum is part of each unit's training at the NTC.

The Joint Readiness Training Center (JRTC) contains rolling, wooded terrain over which infantry and combat support units operate. Ground visibility is not as good as at NTC, and close combat and indirect fires (artillery, mortars) are more common than the long-range attacks by tanks and armored infantry fighting vehicles at NTC. Data from this training center show a fratricide rate of slightly more than seven percent over the last four years.[33] The JRTC uses the first method of fratricide calculation: friendly casualties caused by friendly fire, divided by total friendly casualties.

Fratricide at JRTC is frequent in spite of a rigorous training program, comparable to that at the NTC, to prevent it. The training and command emphasis includes rehearsals of operations and "battle tracking," a system whereby adjacent units frequently report the locations of all of their subordinate organizations. Indirect fires account for only 34 percent of the firing at JRTC; they contribute a stunning 75 percent to the total number of fratricide casualties. As at NTC, units are tested for only several weeks at a time.

The third Army combat training center, CMTC in Hohenfels, Germany, has had similar experiences with fratricide incidents. It reports its fratricide experience using the third method discussed: as raw totals only, without the benefit of a denominator, making it impossible to compare CMTC fratricide rates with data from the other two centers. Recent introduction of new equipment will allow CMTC to collect and present data comparable to that of either of the other two sites in the near future.

It should be underscored that at all combat training centers fratricide prevention is heavily emphasized. Fratricide incidents are reviewed during periodic pauses in each training cycle. They are examined in excruciating detail by the entire chain of command of the unit conducting training and by the training center support organization. It is hard to imagine the issue being more heavily emphasized. Yet the rates are still high, suggesting that perhaps this fratricide prevention technique may have reached its maximum potential. While combat training center data should have been an indicator of trouble ahead, indicators derived from behavioral research were available long before the Persian Gulf War.

Behavioral Research

There are factors operating at our combat training centers and during our wars that explain the existence of high fratricide rates in spite of our present preventive measures. These factors are baseline weapon performance and degradation of skills by stressors, principally sleep deprivation.

As important as training, discipline, planning, and coordination are in the employment of weapon systems, the results produced by any weapon system are determined in large measure by the humans in the system. Their limitations, whether functioning as weapon crew members, artillery fire observers, or fire direction personnel, are well documented.[34] As an illustration, over the period 1985-1989 at the NTC, forward observers could reliably locate stationary targets only with an error of 500 meters (five football fields); only one-third of the initial rounds fired on the targets were classified as either effective or suppressive.[35] These data do not include additional errors attributable to defective munitions. This was the state of the art at that time. Accuracy of forward observers in World War II with a target at 5000 yards also was off by as much as 500 yards, with the result that sometimes artillery shelled its own

troops.[36] It is not unreasonable to believe that similar conditions existed during the Korean War and conflicts prior to World War II. Many weapon systems shared the same problem as the artillery, with accuracy dependent on human judgment. It also should be noted that the recent introduction of laser range finders and laser target designators has compensated for some of these human-induced errors.

Add the effect of combat stressors and performance deteriorates quickly. For readily apparent reasons, the topic of stress was identified as a priority area of military research as early as 1917. Stress-induced decrements in performance are most likely to occur when they can be least tolerated--during critical combat situations.[37] The degradation of combat skills associated with continuous operations is well-researched and published.[38] Sleep deprivation can begin to affect performance significantly 18 to 24 hours into continuous operations, with performance declining 25 percent for every successive day that individuals are awake.

But sleep deprivation effects are uneven. Purely manual tasks are the least affected, while skills requiring complex mental tasks are first to decline.[39] Such critical functions as command and control, fire control, awareness of orientation to friendly and enemy troops, and target designation and tracking are some of the first skills to be affected. Planning activities, so important to success and to fratricide prevention, deteriorate markedly.[40] In short, weapons can still be loaded and fired efficiently over time, but the ability to exercise good judgment and employ the weapon correctly deteriorates rapidly. Abrupt and serious failures are prone to appear. In addition, vigilance is a big problem. Research recommendations include posting sentries in pairs during severe combat stress because of the propensity for visual illusions and failure to detect targets.[41] In the words of a 1953 study: "The tempo of warfare is increasing. It is becoming more and more evident that the human organism is one of the primary limiting factors in determining the success or failure of a military operation."[42] It would appear that the pace of the modern battlefield is moving beyond the abilities of its human participants to react appropriately over extended periods of combat.

The consequences of degradation of ability quite logically apply to conditions that can cause fratricide. Combat identification failures and poor situational awareness are the two major reasons for fratricide and were the two main causes in the Persian Gulf War.[43] Situational awareness refers to land navigation errors (being in the wrong place) and insufficient coordination between units and individuals as they move about the battlefield. Unrecorded unit movements when combined with inaccurate or ill-defined target reference points can be lethal. It is precisely these skills that are degraded early by continuous operations. A participant in the ground assault of the Persian Gulf War describes the situation:

> It was round the clock battle, a blow deep in the heart of enemy territory. It was fought at a furious pace, in rainstorms and sandstorms, with killing systems of ferocious ability. It left many soldiers . . . looking for help when picking out the good guys from the bad guys.[44]

The degrading of skills did not begin when contact with the enemy began. It began with the movement to contact and the sleep deprivation that started to accumulate as early as 24 hours previously.

Even rested, alert individuals are vulnerable to serious error under stress. Air Force research and work done by others demonstrate the effects of stress on error generation. Human attention capacity is thought to be limited in quantity and therefore allocated in proportion to the number of items needing attention and their importance. Threatening objects receive proportionally more attention than do non-threatening objects and information. This is referred to as attention gradient or divided attention. People placed in a life-threatening environment allocate attention to the most threatening aspect, be it an aircraft, a tank, or a soldier. In a complex situation with many input variables affecting the subject, contradictory evidence about what is assumed to be an enemy often gets little or no attention when the expectation is that the target is the enemy. On the modern battlefield, with its proliferation of high velocity and high volume fires, this has serious implications. Situational awareness cues will decline, so soldiers and equipment will be increasingly misidentified if the expectation is that the enemy is present.[45]

Researchers using early combat simulation models to assess the need for combat identification systems to prevent fratricide did not incorporate into their systems the large body of knowledge on the effects of stressors on human performance and judgment.[46] This unintentional oversight resulted in an unrealistic expectation of consistency in human performance; that oversight tended to lower expected, and hence projected, fratricide rates.

In summary, a major reason the fratricide rate remains so high is that imperfect human skills and judgment needed to employ weapon systems quickly degrade under multiple stressors, all made worse by the continuous operations that seem to characterize the tempo of modern war. "The stressors inherent in the combat environment . . . impose severe debilitating effects on performance."[47] Our combat training centers reflect this fact, and our most recent experience in combat confirms it.

The Desert Storm Experience

Many Americans not familiar with the issue of fratricide were appalled to learn of the high casualty rate in the Gulf War from our own weapons. Of the 613 US military battle casualties in Operation Desert Storm, 146 were killed in action, including 35 (24 percent) killed by friendly fire. Of the 467 wounded, 72 (15 percent) were by fire from friendly weapons, for an overall average of 17 percent.[48] A full 77 percent of all combat vehicles lost were destroyed by friendly fire.[49] This was in spite of comprehensive training in the desert prior to the onset of the war, extensive and repeated operational rehearsals, and the use of Fire Support Coordination Lines (FSCL), combat identification markers on vehicles, high-tech navigational systems, and extensive liaison networks to integrate different ground and air elements.[50]

The fratricide rates experienced in Desert Storm are consistent with all that has been discussed here. There is ample historical precedent and training center verification for the fratricide incidents that occurred in that operation. Behavioral research sheds light on the reasons for decrements in human ability and the limitations of training. There is no reason to believe that fratricide rates in war would be lower than in training. In addition, unlike in prior conflicts, US forces in Southwest Asia had unique capabilities to identify losses due to fratricide. These included the use of weapon-mounted video cameras to record hits and depleted uranium rounds that unequivocally marked their targets as US hits. The short duration of the Persian Gulf War also allowed for immediate attention to be focused on battle damage evaluations. In essence, the new conditions of this war allowed for the most accurate accounting of fratricide events we have ever attempted.

So it is against this background of historically high fratricide rates, significant training fratricide rates, behavioral research, and more accurate determination of weapon results that the Persian Gulf War data should be viewed. Clearly a new course on fratricide prevention needs to be charted to prevent our next experience from mirroring the past.

Implications

The view of fratricide presented here calls for a reexamination of many issues. Here are some that seem to be among the most important.

Fratricide prevention must have high priority because our fratricide rates will become a serious political and ethical issue in future conflicts. Public outrage over continued high fratricide rates--the ten to 15 percent suggested here--could make it politically impossible to prosecute a war successfully. Because the country understands the meaning of fratricide, the public may well ask, Why was this not fixed after Desert Storm? Discussions about using the wrong method of calculation or a more-palatable denominator will be irrelevant. Charles Shrader made the point that "whether the loss, permanent or temporary, of 2 percent of the nation's military in a given conflict is significant and thus demands an extraordinary application of resources to avoid is a question that must be answered at the highest policy levels."[51] With evidence to suggest that rates may be at least five times that high, we should give full attention and additional funding to fratricide prevention. We cannot repeat the Gulf War fratricide rates in a future conflict.

Reducing fratricide rates will provide a significant battlefield advantage for the American military. As Colonel Shrader remarked, "The impact of amicicide [fratricide] on combat power is geometric, not linear. Each fratricide incident represents one bomb, shell, or bullet that should have fallen on the enemy to reduce his combat power rather than our own."[52] Our foes on the battlefield suffer as we do from reduction in baseline performance ability of weapon systems and the decline in human abilities related to the tempo of combat operations. Any significant improvement in fratricide rate for our forces will put our foes at an additional disadvantage. And the advantage is not only on the combat end of the equation. Every friendly tank or vehicle spared the effects of friendly fire is one less that has to be "force projected."

Current US strategy involves harnessing technology to give us an edge on the battlefield. A 50-percent reduction in fratricide rates translates to a five- to eight-percent increase in combat power. The opposite is also true: allowing the fratricide rate to rise because of emerging battlefield characteristics will significantly degrade our ability to fight and win. This is another aspect of the technological edge we can leverage.

Measures presently in use are not effective enough to reduce fratricide incidents. The Center for Army Lessons Learned (CALL) states in their 1992 newsletter *Fratricide: Reducing Self-Inflicted Losses*: "The key to solving fratricide problems is detailed planning and rehearsals to minimize predictable risks."[53] If these efforts were sufficient, incidents of fratricide would fluctuate by unit based on planning and rehearsal, not by type of engagement, as data from the NTC show. Yet even after intensive training, planning, and rehearsals before the Desert Storm ground campaign, the residual rate of fratricide remained unacceptably high. Nor are the high rates at our combat training centers the result of ignorance, indifference, or inattention to doctrine. Instead, all the data argue for an inherent, intrinsic risk associated with each type of maneuver, rather than relative rates subject to control by planning or rehearsal. While planning is certainly important to keep fratricide incidents low, it will continue to have only a limited effect on the rate. Because of the pace of modern warfare and the degradation of human performance during continuous operations, we may be approaching the minimum levels of fratricide attainable using current preventive methods.

As an interim measure, a reemphasis on the importance of sleep discipline will begin to address the steep decrements in performance and judgment associated with sleep deprivation. Initial emphasis must be on those personnel in command and control centers and key leaders from platoon level up. The heavy responsibilities of command and the continuous tempo of warfare will make this measure difficult to enforce, yet the means must be found to do so.

The modern battlefield is predisposed to increased fratricide rates. Modern combat limits many fratricide prevention measures, including heightened planning and rehearsals, from being applied:

> Continuous land operations [are part of] advanced warfare. [They are] made possible by the almost complete mechanization of land combat forces and by the technology that permits effective movement at night, in poor weather, and in other low visibility conditions. . . . The reasons that armies have traditionally paused in battle--darkness, resupply, regrouping--have been overcome largely by technological advances.[54]

One of the potentially weak links on the modern battlefield is the Army's most sophisticated system, the soldier. Continuous operations at times require human participants to exercise ability and judgment at a superhuman pace, a fact that is repeatedly overlooked by scholars and soldiers alike. Recent publications speak about fratricide as a result of direct human error, fire discipline, carelessness, and lack of coordination.[55] These statements are true but do not go far enough. These errors are natural outcomes of human behavior in the environment into which we have placed soldiers. While the AirLand Battle concept may be terribly effective against the enemy, by its very nature it is also hazardous to friendly troops.

Technology will permit the development and routine use of an IFF-type of system for ground warfare. During the Gulf War, methods of acquiring targets in armored divisions were consistent at 3000 meters, with first round hits at 2500 meters, often beyond the ability of tank crews to identify the target consistently. Technologies exist in our laboratories that allow acquisition of targets at 4000 meters, with the potential of acquisition at 5000-7000 meters in several years.[56] These ranges are well beyond visual identification abilities even with visual aids. The air-to-ground Maverick missile shares this same mismatch between technology and human behavior. It must be fired as the aircraft approaches its ground target before visual identification of the target is possible. The missiles lock onto targets and do not discriminate between friend or foe.[57] The sophistication and range of modern weapons have outpaced the ability of humans in the system to identify many targets with sufficient assurance to preclude fratricide incidents. We need an improved ability to identify targets out to the maximum range of weapon and target acquisition with much lower probabilities for error than is now possible.[58] Technology will have to provide an answer to this problem for surface warfare, much as it solved the problem for air warfare.

Similar or identical weapon systems in the hands of friend and foe will push us inexorably toward ground IFF

technology. Many US weapons are widely sold or reproduced throughout the world. It is possible that future adversaries will possess vehicles, tanks, and weapon systems that are identical to ours. Sorting out friend or foe in night combat, combat with fluid lines, and in close air support missions will be impossible with present methods.

Even weapon systems on opposing sides that are developed independently are often distressingly similar in appearance. They look alike and have the same characteristics because of technical and engineering requirements used to enhance capabilities--a trend called convergent evolution. Military helicopters are a good example of this tendency for equipment to appear similar although developed independently, as the tragedy over Iraq demonstrated.

Joint doctrine will require us to revisit the issue. Joint operations require complex coordination and command and control arrangements. Close air support historically has been plagued with difficulties in identifying friendly forces on the ground. The continued movement toward joint close air support under a single air manager will involve Navy, Air Force, and Army aircraft traveling hundreds of miles an hour with seconds over a target to discriminate between friend and foe. These are optimal conditions for fratricide. The operations of different services will have to be integrated to an extent not yet attempted. And this article has not even mentioned the potential for fratricide in coalition or combined operations.

The force projection pillar of our National Military Strategy will increase factors favorable to fratricide. Cold War doctrine used the principle of forward defense, initially employing troops already overseas, combat-ready, oriented to the terrain, and adjusted to the time zone. The new strategy of force projection can insert large numbers of troops into a hostile, unfamiliar area after considerable travel time with its concomitant lack of sleep, time zone changes, and disruption of diurnal rhythms. All these circumstances produce serious degradation of ability and judgment. The Persian Gulf War allowed weeks to train and acclimatize after the last combat units closed in theater. Fratricide will get worse under more difficult operational circumstances.

A future battlefield that includes a nuclear, biological, or chemical environment will increase fratricide rates. Careful research on the effects of Mission Oriented Protective Posture (MOPP) equipment demonstrates up to a fourfold increase in fratricide rates over baseline data when wearing this equipment for long periods of time. The MOPP equipment causes tremendous problems with vision and hearing. These sensing abilities are critical for command and control and coordinated physical performance,[59] areas where we already have seen that significant degradation produces conditions conducive to fratricide.

An additional component needs to be added to our current plan for fratricide reduction. This has only recently become apparent. A 1982 TRADOC study concludes, "There is no significant evidence to indicate that existing operational command and control procedures are not sufficient to control fratricide to acceptable operational levels,"[60] an assertion that we must examine closely. High fratricide rates persist in spite of preventive measures; the evidence is in our combat training centers and our recent wars. Our soldiers need help in distinguishing between friend and foe.

A technological solution has generally been effective for the Air Force. Their identification friend or foe (IFF) system, which uses transmitters that permit pilots to query an IFF system on board an approaching aircraft, has successfully dealt with closing with targets before visual identification is possible. The appropriate return signal identifies a friendly aircraft: otherwise it is considered the enemy. During the six-week Persian Gulf War air campaign, when tens of thousands of air sorties were flown, there were no incidents of air-on-air fratricide. An integrated ground system has the same potential.

Such technological solutions to address the fratricide issue have met with some hostility:

> There appears to be an unwarranted faith in eliminating amicicide [fratricide] through the application of some technological remedy. . . . The solutions to the problem of friendly fire, if any, are more likely to be human rather than mechanical. Increased emphasis on training, combat conditioning, fire discipline, planning and coordination of operations, and keeping the troops informed is likely to produce more joy than all the expensive technological toys combined. [61]

This source attributes fratricide to carelessness, stress of combat, lack of training, lack of discipline and fire control,

and lack of coordination.[62] Studies of human behavior make clear that of these causes, all except lack of training have been demonstrated to degrade quickly during combat and are not amenable to compensation through training. Prevention of errors in these instances requires different kinds of controls than have heretofore been available in ground combat operations.[63]

The benefit to be gained from technology is at minimum a safety check, with no upper limit on the potential for control and coordination measures. It adds another dimension of the known to all the unknowns of the battlefield. It can help to compensate for the anxiety, fear, uncertainty, and exhaustion that are the seeds of fratricide. These factors have been with us since the beginning of modern armies, and successive strategies to deal with them have brought us to where we are today. Introducing technology to counter fratricide in ground combat operations is one of the few options we have not exercised.

We need consistency in our terms and methods of calculating fratricide. The fratricide calculations at JRTC (see Table 1) use the first method discussed (friendly casualties from friendly fire, divided by total friendly casualties). Those calculations are consistent with the method used in all the historical evidence presented. The fratricide data from NTC use a method easily converted to the second method of calculation, with the denominator being enemy casualties. The recently published Center for Army Lessons Learned newsletter on fratricide juxtaposes these two very different fratricide calculations, derived by different methodology because of different logic. In the same newsletter CMTC data are noted to have a "similar" experience although in reality the data are not comparable.[64]

Confusion over methodology has notable implications. That the two methods of fratricide calculation at present are somewhat similar in final result is coincidental; the methods are based on fundamentally different assumptions and relationships. Using the data from both interchangeably is confusing and will produce incorrect conclusions unless carefully explained. A common method of calculation should be used to facilitate cross analysis and understanding of training center experiences. The combat training centers should have the capability to use as the "gold standard" the second method, which reflects the efficiency of inflicting harm on the enemy (friendly casualties caused by friendly fire, divided by enemy casualties). Instrumentation at the training centers could allow this kind of data to be captured and analyzed. It may be that our high-technology weaponry is very efficient in dispatching the enemy. If so, fratricide rates from this method will be low.

Unfortunately this denominator (enemy casualties) has not been available in combat operations, nor can anyone reasonably expect it to be available in future conflicts. We thus will have to settle for the historical method of presenting fratricide in war by using method one: percent of friendly casualties due to friendly fire, divided by total friendly casualties. Comparing fratricide data from war and training centers therefore will require the use of both methods; any mixing of methods needs to be carefully labeled and understood. There is one potential advantage to be gained from this recommendation. If fratricide rates are really lower by method two (which is not borne out by NTC data), comparable results from our combat training centers calculated using both methods will allow us to explain our fratricide rates in war. We ought to be able to develop the means to make the conversion from one method to the other as routine as we now calculate other aspects of combat operations.

We must take the known limitations of human performance into account when running computer simulations and testing equipment for the battlefield. The body of knowledge addressing human abilities in continuous operations has been well articulated for the last 20 years. The steep decline in human abilities due to stressors like sleep deprivation has long been recognized. We need to incorporate this knowledge into simulations, whether of operations or weapon capabilities, to allow us to compensate for decline in individual abilities over time in combat. Few studies take into account this decline. The requirement to do so in support of sustained ground operations by a small Army and Marine Corps is almost self-evident.

The Future

Fortunately, a reassessment of the priority given to fratricide prevention is beginning. After the Persian Gulf War, the House Armed Services Committee requested that the Office of Technology Assessment (OTA) review the technology and techniques available to reduce fratricide.[65] This excellent review concluded that the technology for avoiding fratricide of land surface targets lags behind the technology important to avoiding aircraft accidents.[66] It advocates

priority funding to find better solutions. Our land systems are acquiring the same characteristics as those of aircraft--rapid movement, short closing intervals to determine friend or foe, and usually lethal first shots. The OTA report, however, does not emphasize the tremendous effect of stressors on abilities and judgment.

Defense Department guidelines have assigned the Army as the lead agency for ground-on-ground and air-on-ground combat identification systems. It appears the Army is moving along two fronts. The Army Materiel Command is pursuing two technologies to deal with combat identification and situational awareness. The Training and Doctrine Command is approaching the problem from the standpoint of leader development. These are mutually supporting strategies. As one writer notes, "Technology is a great enhancer, and it supplements what is really the glue that holds the Army together--training and discipline." [67]

The 1st Cavalry Division is scheduled to be the first unit "digitized"--in 1996--under a long-established effort to improve combat effectiveness. Digitization of the battlefield refers to the process in which voice, text, and maps are converted into computer code. By linking forces on the battlefield into a single digital network, a commander can "see" the battlefield on a screen. This enables a commander to increase concentration and synchronization of fires, improve intelligence collection, and, one hopes, reduce fratricide by increasing situational awareness and combat identification.[68] This system was not conceived as an anti-fratricide system, although it could aid in that effort. Still, it will be of no help to dismounted infantry not accompanied by vehicles. A recently announced acceleration of fielding calls for the entire XVIII Airborne Corps to be digitized by the end of the century.[69] However, sufficient funding for the entire Army is thought to be a serious problem.

A specific fratricide prevention measure under development is the millimeter-wave (MMW) device. This system, similar to the Air Force IFF system, sends out an interrogating signal that queries a target vehicle. If there is an appropriate coded response, the target is identified as friendly. This vehicle-mounted system will not, however, aid dismounted soldiers. A field test of the MMW device is expected in 1996. It will be expensive to provide each vehicle on the battlefield with such a device.

With regard to the fighting soldier, one point is certain. Soldiers who are casualties of friendly fire are no less brave or courageous. Many soldiers go into battle knowing the risks include fratricide, having met the issue at our combat training centers and observed its occurrence in training. A sort of gallows humor surrounds it. During World War II, the US Ninth Air Force was so often off target and on friendly forces that they were dubbed "The American Luftwaffe."[70] German troops in World War I resorted to calling their 49th Field Artillery Regiment the 481/2 because of the unit's propensity to fire short rounds on them.[71] The soldiers of the future will continue to have fratricide as their unwelcome companion on the battlefield. We must use every possible means to reduce the rate.

Finally, what should our attitude be toward those who, under conditions of high stress and fatigue, are discovered to have inflicted friendly casualties while demonstrating no negligence? Even under the best of circumstances, if such a term can be used in regard to war, fratricide will occur. The evidence presented here suggests its inevitability due to mismatches between weapon capabilities and the endurance of weapon crews. With the failure of measures to prevent fratricide, should we subject these individuals--whom we have placed in a position of such certain errors--to the guilt of a mistake that is not entirely theirs? The modern battlefield's vigorous, violent, continuous combat assures fratricide. Until an adequate combat identification system is in place, there will be many such individuals in every conflict.

Conclusion

This article does not blame anyone for the past. Rather, the charge to our present and future leaders is clear: We need a solution to this problem. Had alleviating fratricide been possible during this century, the effects would have been tremendous. If a conservative US fratricide estimate of ten percent is used for 20th-century conflicts, the following fratricide casualties result: 5000 killed and 23,000 wounded in World War I; 19,000 killed and 72,000 wounded in World War II, 5400 killed and 10,300 wounded in the Korean War, and 5800 killed and 36,500 wounded in Vietnam. For more recent conflicts we have the actual counts presented earlier. The aggregate total is approximately 177,000 casualties. A 15-percent fratricide rate is equivalent to a quarter of a million casualties in the 20th century. The technology that increases the lethality of ground combat provides the means to reduce its effect on friendly troops.

We must acknowledge the magnitude of the problem. Fratricide rates have been, conservatively, ten to 15 percent of

our casualties, not two percent. The magnitude of this aspect of war's friction is a burden every 20th-century soldier has had to carry. When fratricide is explained in terms of human inability to cope with the stressors of the battlefield, instead of human error or stupidity, it will become clear that something besides training is needed. The American people will support funding the effort for solutions.

The time has come for a technological initiative to decrease fratricide. The historical fratricide rate and combat training center data confirm the need. The battlefield trends of the future will require it, and we must sustain the effort to find appropriate solutions for it. Reduction, if not elimination, of fratricide will increase our combat power relative to our foe, conserve our resources, and most important, protect and save human lives. Prototypes are being funded and fielded.

An armed forces-wide common strategy in fratricide calculation, presentation, and research needs to be developed. The present system is confusing to the military and to the public. There are no Navy, Marine, joint, or DOD definitions. Fratricide is a joint issue, but only TRADOC has advanced a definition of it. We must have common definitions and calculation standards to understand one another. Achieving that in our dialogue will facilitate development of preventive measures and doctrine applicable to all services.

Research has suggested the limitations of human ability and judgment under combat conditions. The relationship between weapon systems and human judgment requirements needs to be carefully studied. Some present-day weapon systems rely on human judgment under conditions and distances where such judgment is known to be faulty. Intervention in these areas will be required.

This article relies to a great degree on data involving the Army, but the problems articulated here are joint ones. The Persian Gulf War was a paradigm of what is to come, and the services must find solutions to fratricide together. As Colonel Shrader remarked, "It may well be that in the fog of war, friendly fire casualties are inevitable, but this solemn observation does not absolve the armed forces from doing everything in their power to eliminate the problem."[72] It is an investment of energy, time, and money we can afford to make.

NOTES

The author would like to acknowledge the immense help of Colonel David Sa'adah from OTSG; Colonel Stephen Bowman from USAMHI; the assistance of the library staffs at the Military History Institute and the Army War College; and the support of his family.

1. Charles R. Shrader, *Amicicide: The Problem of Friendly Fire in Modern War* (Fort Leavenworth, Kans.: Combat Studies Institute, US Army Command and General Staff College, 1982), p. 108; US Congress, Office of Technology Assessment, *Who Goes There: Friend or Foe?* OTA-ISC-537 (Washington: GPO, June 1993), p. 30.

2. Charles R. Shrader, "Friendly Fire: The Inevitable Price," *Parameters*, 22 (Autumn 1992), 31; US Department of Defense, *Conduct of the Persian Gulf War, Final Report to the Congress* (Washington: Department of Defense, April 1992), Appendix M, pp. M-1, M-2.

3. US Department of the Army, *Military Operations: U.S. Army Operations Concept for Combat Identification*, TRADOC Pam 525-58 (Fort Monroe, Va.: Training and Doctrine Command, 31 August 1993), p. 1.

4. US Department of the Army, *Fratricide: Reducing Self-Inflicted Losses*, Newsletter, No. 92-4 (Fort Leavenworth, Kans.: Center for Army Lessons Learned, US Army Combined Arms Command, April 1992), p. 5.

5. Operations Research Office, "The Relationship of Casualties to Tactics and Ammunition Expenditure. Korea: 1 Feb 1953-31 Mar 1953," Operational Research Office, Wound Ballistic Research Team Report, 1953, p. 5, found in US Army Military History Institute library (hereinafter USAMHI), Carlisle Barracks, Pa.

6. Robert J. Best, *The Structure of a Battle: Analysis of a UN-NK Action North of Taegu, Korea, September 1950* (Chevy Chase, Md.: Operations Research Office, Technical Memorandum ORO-T-261, The Johns Hopkins

University), pp. 5-7, 78-88, 282-83.

7. Shrader, *Amicicide*, p. 105.

8. Shrader, "Friendly Fire," p. 31.

9. Trevor N. Dupuy, *Attrition: Forecasting Battle Casualties and Equipment Losses in Modern War* (Fairfax, Va.: Hero Books, 1990), p. 3.

10. US Department of the Army, Regulation 600-10, *The Army Casualty System* (Washington: Headquarters, US Army, 1985).

11. Shrader, "Friendly Fire," p. 30.

12. US War Department, *War Department Annual Report 1917*, Vol. 1, Report of the Surgeon General (Washington: GPO, 1918), pp. 483, 694-95.

13. US War Department, *War Department Annual Report 1919*, Vol. 1, Part 3, Report of the Surgeon General (Washington: GPO, 1920), pp. 3006-08.

14. L. D. Besecker, Regimental Aid Station Record, 23d Infantry Regiment, 2d Division, 15 March - 3 June 1918, found in World War I Veterans Survey, Archives Branch, USAMHI, Carlisle Barracks, Pa.

15. Alexandre Percin, *Le Massacre de notre Infanterie 1914-1918* (Paris: Albin Michel, 1921), pp. 10, 13-14, 217-18.

16. Ibid., pp. 217-18.

17. Shelford Bidwell and Dominick Graham, *Fire Power: British Army Weapons and Theories of War, 1909-1945* (London: Allen and Unwin, 1982), p. 111.

18. James E. T. Hopkins, "Casualty Survey--New Georgia and Burma Campaigns," in *Wound Ballistics*, ed. James C. Beyer (Washington: Office of the Surgeon General, Department of the Army, 1962), pp. 237-80, 769-806, from the series, *Medical Department United States Army in World War II* (supplemented by experiences in the Korean War), ed. John Lada.

19. Ashley W. Oughterson et al., "Study of Wound Ballistics-Bougainville Campaign," in *Wound Ballistics*, pp. 281-436.

20. Gilbert W. Beebe and Michael E. DeBakey, *Battle Casualties: Incidence, Mortality and Logistic Considerations* (Springfield, Ill.: Charles C. Thomas, 1952), pp. 159-61.

21. Brian Wynne Garfield, *The Thousand-Mile War: World War II in Alaska and the Aleutians* (New York: Ballantine Books, 1969), pp. 334-35.

22. James C. Beyer, James K. Arima, and Doris W. Johnson, "Enemy Ordnance Materiel," in *Wound Ballistics*, pp. 77-79.

23. Carl M. Herget, George B. Coe, and James C. Beyer, "Wound Ballistics and Body Armor in Korea," in *Wound Ballistics*, pp. 691-767.

24. Jeffrey A. Burt and Janice T. Engleman, *Distribution of Combat Casualties by Causative Agents* (McLean, Va.: Research Analysis Corporation, Technical Memorandum RAC-T-445, 1965), pp. 32-41.

25. Robert J. Best, *Analysis of Personnel Casualties in the 25th Infantry Division 26-31 July 1950* (Chevy Chase, Md.: Operations Research Office, Technical Memorandum ORO T-22 [FEC], The Johns Hopkins University, 1952), pp. 3-4, 38.

26. Joint Technical Coordinating Group for Munitions Effectiveness, *Evaluation of Wound Data and Munition Effectiveness in Vietnam* (WDMET), Volumes I-III, Joseph Sperrazza and Joseph R. Blair, co-chairmen (Alexandria, Va.: Defense Technical Information Center, AD 879-516, 879-517, 1970), I, 1-3 to 1-35.

27. Ibid., I, 2-17, Table 4.

28. Ibid., III, Appendix C, p. C-7, Table 4.

29. Ibid., I, 3-1 to 3-63.

30. Charles F. Hawkins, "Friendly Fire: Facts, Myths and Misperceptions," *Proceedings*, 120 (June 1994), 54-59.

31. US Department of Defense, "19 June 90 Regular Briefing," Pentagon (Pete Williams), found on electronic retrieval system, "Lexis-Nexis," Services of Mead Data Central, Inc., Federal News Service, 19 June 1990.

32. US Department of the Army, *Fratricide*, p. 6, Appendix E.

33. Ibid., p. 5; personal communication, LTC Bruce Brant, Senior Controller, JRTC, 15 March 1994.

34. Peter Watson, *War On The Mind: The Military Uses and Abuses of Psychology* (New York: Basic Books, 1978), pp. 45-93.

35. Martin Goldsmith, James Hodges, and Marion L. Burn III, *Applying the National Training Center Experience: Artillery Targeting Accuracy* (Santa Monica: RAND, N-2984-A, April 1990), pp. 29-32.

36. Watson, p. 67.

37. Reuven Gal and David Mangelsdorff, ed., *Handbook of Military Psychology* (West Sussex, England: John Wiley & Sons, 1991), p. 184.

38. Arthur I. Siegel et al., *Human Performance in Continuous Operations, Volume I: Human Performance Guidelines* (Wayne, Pa.: Applied Psychological Services, 1979), pp. 75-437; Gal and Mangelsdorff, *Handbook*; Felix Kopstein et al., *Soldier Performance in Continuous Operations*, US Army Research Institute for the Behavioral Sciences, Defense Technical Information Center (DTIC) AD-A160 470, 1985; Arthur I. Siegel et al, *Human Performance in Continuous Operations, Volume III: Technical Documentation* (Wayne, Pa.: Applied Psychological Services, 1980), pp. 1-5; Elmar Dinter, "Stamina and Exhaustion," *Hero or Coward: Pressures Facing The Soldier In Battle* (London: Frank Cass and Company, 1985), pp. 27-33.

39. Kopstein et al., *Soldier Performance*, pp. 6-13, 79-82; Siegel et al., *Human Performance in Continuous Operations, Volume III: Technical Documentation*, pp. 1-5; Gregory Belenky et al., "The Effects of Sleep Deprivation on Performance During Continuous Combat Operations," in *Food Components To Enhance Performance*, ed. Bernadette M. Marriott (Washington: National Academy Press, 1994), pp. 177-85.

40. Walter Reed Army Institute of Research, "Effects of Continuous Operations (CONOPS) on Soldier and Unit Performance: Review of the Literature and Strategies for Sustaining the Soldier in CONOPS," (Washington: A Joint WRAIR/ARI Report, WRAIR Technical Report No. BB-87-1, 1987), pp. 1-4, 1-5.

41. Felix F. Kopstein et al., *Human Performance in Continuous Operations, Volume II: Management Guide* (Wayne, Pa.: Applied Psychological Services, 1979), pp. 11-18.

42. US Department of the Navy, Office of Naval Research, Unit 1 and The Office of the Surgeon General, US Army, *A Study of Combat Stress: Korea 1952* (Washington: GPO, 1953), p. 1.

43. US Department of the Army, *Fratricide*, pp. 9-10.

44. Julie Bird and Tom Donnelly, "Friendly Fire," *Army Times*, 19 August 1991, p. 3.

45. Martin L. Fraker, "Attention Gradients in Situational Awareness," in *Situational Awareness in Aerospace Operations*, by the Advisory Group for Aerospace Research and Development (AGARD), Conference Proceedings No. 478 (Copenhagen: North Atlantic Treaty Organization, 2-6 October 1989), pp. 6-1 to 6-10; Michael I. Posner, ed., *Foundations of Cognitive Science* (Cambridge, Mass.: Massachusetts Institute of Technology Press, 1989), pp. 632-42.

46. Paul V. Catanach et al., *Subject: Combat Development Study-Battlefield Identification, Friend or Foe (BIFF)* (U) (White Sands Missile Range, N.M.: US Army TRADOC Systems Analysis Activity, Report no. TRASANA TR-14-82, 1982), pp. 20-27.

47. Gal and Mangelsdorff, *Handbook*, p. 183.

48. US Department of Defense, *Final Report to Congress*, Appendix M, p. 589.

49. US Department of Defense, Office of the Assistant Secretary of Defense for Public Affairs, News Release on Friendly Fire, 13 August 1991, pp. 1-2.

50. US Department of Defense, *Final Report to Congress*, Appendix M, pp. 592-94.

51. Shrader, *Amicicide*, p. 106.

52. Ibid., p. 106.

53. US Department of the Army, *Fratricide*, foreword.

54. US Department of the Army, *Soldier Performance in Continuous Operations*, Field Manual 22-9 (Washington: Headquarters, US Army, 1991), p. v.

55. Shrader, *Amicicide*, p. 107; US Congress, Office of Technology Assessment, *Who Goes There: Friend or Foe?* pp. 7-36.

56. Dennis Steele, "New Technology Targets Friendly Fire Deaths," *Army*, April 1993, p. 40.

57. David C. Morrison, "Foes Not The Only Threat in Gulf War," *National Journal*, 9 February 1991, p. 335.

58. US Department of the Army, *Combat Identification Program Interim Report* (Fort Monroe, Va.: US Army Training and Doctrine Command, 12 December 1991), p. 2.

59. US Army Chemical School, *Combined Arms in Nuclear/Chemical Environment. Force Development Testing and Experimentation: Summary Evaluation Report Phase I* (CANE I FDTE) (Fort McClellan, Ala.: US Army Chemical School, March 1986), pp. 1-1 to 1-3, 2-4 to 2-8; US Army Chemical School, *Summary Evaluation Report (SER) for Combined Arms in a Nuclear/Chemical Environment (CANE) Force Development Test and Evaluation (FDTE): Close Combat Light (CCL)* (Fort McClellan, Ala.: US Army Chemical School, May 1993), pp. 2-4 to 2-10.

60. Catanach et al., p. vi.

61. Shrader, "Friendly Fire," pp. 41-42.

62. Ibid., pp. 39-40.

63. Dinter, "Stamina and Exhaustion," p. 27.

64. US Department of the Army, *Fratricide*, pp. 5-6.

65. US Congress, Office of Technology Assessment, *Who Goes There: Friend or Foe?* p. 1.

66. Ibid., p. 4.

67. Steele, p. 37.

68. Sean D. Naylor, "Digitization Speeded Up," *Army Times*, 21 March 1994, p. 31.

69. Ibid.

70. Lee Kennett, *G.I.: The American Soldier in World War II* (New York: Charles Scribner's Sons, 1987), p. 175.

71. John Ellis, *Eye Deep in Hell: Trench Warfare in World War I* (New York: Pantheon Books, 1976), pp. 61-62.

72. Shrader, *Amicicide*, foreword.

Colonel Kenneth K. Steinweg, M.D., is Commander, General Leonard Wood Army Community Hospital, Ft. Leonard Wood, Missouri. He is a graduate of Washington and Jefferson College and earned his M.D. degree at the University of North Carolina School of Medicine; he also has studied geriatrics at East Carolina University and is a 1994 graduate of the US Army War College. Colonel Steinweg has been an Army family practice physician, held staff positions with the Office of the Surgeon General in Washington, and commanded the 5th M.A.S.H. in Saudi Arabia during Operations Desert Shield and Desert Storm.

Reviewed 25 November 1996. Please send comments or corrections to carl_Parameters@conus.army.mil.