AMMA JOURNAL VOL 7 ISSUE 2
AUGUST 1998

Understanding weapons effects. A fundamental precept in the professional preparation of military physicians[1]

by
A.M. Smith, R.F. Bellamy [2]

Short of participation in medical support of actual combat, there is no optimal educational medium to facilitate competence in the precepts of wartime casualty care. Consequently, there have been periodic calls for "military specific curricula" to help orient medical officers to the differences between the unique science of military medicine, and the practice of medicine in a peacetime military. Intimately, any such military specific course of study should facilitate its students' understanding of the medical impact of weapons systems. The insights gained will foster a greater understanding of the entire spectrum of casualty care systems in war.

Whereas the profession of combat arms has traditionally focused its attention upon the relationship between weapons, ammunition, and their targeting, a concurrent appreciation for the impact of munitions upon human targets, and the wounding process, would benefit military physicians. Empowered with a better understanding of the physical impact of specific weapons, physicians can better comprehend the rationale for their tactical utilisation. Further endowed with a knowledge of the special requirements for management of resulting combat injuries, medical officers may logically develop a greater appreciation for medical logistics needs as well. This level of professional insight will permit them to competently assess the intrinsic assets and liabilities of the casualty treatment continuum supporting operational plans, and thereby assist combat commanders in becoming better informed “consumers” of medical care services.

Weapons Effects

The military value of contemporary armaments is primarily adjudged by their effectiveness in producing physical trauma. Through the combined destructive forces of projectiles, blasts and incendiary agents, the judicious employment of today's combat weapons may create a diverse and widely distributed spectrum of personnel damage. Rationally, however, the goal of modern warfare is not necessarily to annihilate an adversary, but more directly to reduce an enemy's capability for further resistance. Whether through intimidation or physical damage, the military usefulness of weapons must ultimately be judged in terms of their contribution to this objective. Indeed, the proportion of non-lethal injury may have an even greater impact on operational success than the absolute number of deaths among an opponent's forces.

Observations on the fear that men develop relative to specific weapon are unfortunately quite limited. While the extent to which military effectiveness correlates with the potential for generating fear is a concept not well understood, history suggests that its role can occasionally be pivotal. For example, whistles were added to some aerial bombs during World War II specifically for psychological effect. Perhaps the best example of a weapon system designed for the purpose of intimidation was the German "Stuka" dive bomber of World War II. When diving on its target, a wind-driven siren attached to its wing was activated. Known as the "Jericho Siren", an ear-piercing shriek was produced which was loudest just before the bomb exploded. Likewise, some of the appeal of chemical weapons lies in their presumed psychologic effects as well. Except for chemical agents, however, the design of pre-nuclear weapons was not significantly influenced by psychologic considerations.

The character of modern weapons is ever-changing, however, and considerable advances have been made in broadening and increasing their effectiveness. Furthermore, the principles of their use have been expanded. Given the often unique constitution of each tactical situation, these improvements, together, may provide an increasingly greater variety of options for operational commanders. Regardless of the methods employed, the time-honoured axiom remains valid: increasing the proportion of wounded among adversary forces is a very effective "force reducer".

Effective antipersonnel weapons cause not only multiple casualties in a population of troops, but may also inflict multiple wounds in each of their affected targets. In evaluating the potential effectiveness of a new exploding missile, the principal question to be asked is: "How far does it go in expanding the fragmentation envelope?" Rephrased in the context of intensity of injury: "How can more hits be produced without reducing the summation of damage - by creating too many minor hits and too few major hits?''

From the perspective of weapons designers, exploding missiles carry a far greater probability of hits than solid projectiles of the same size. From a medical standpoint, a weapon producing multiple random wounds is more likely to injure a critical organ than a single injury caused by an aimed missile such as a rifle bullet. Furthermore, by creating greater numbers of casualties among opposing forces, many with multiple wounds, the enemy force will not only be weakened, but the logistic needs of their medical services will be increased. This may often evolve at the expense of the combat arms, since more enemy logistical resources and personnel will need to be withdrawn from offensive operations to care for the injured and facilitate their evacuation.

Weapons Effectiveness: The Tactical Impact

As a tactical situation changes, differing degrees of injury intensity may vary in their military impact. In one situation, where enemy capabilities for replacement are not great, as in the attack on an isolated strong point, weapons capable of only transient impairment of efficiency, although affecting a substantial part of the enemy force, may be of greater tactical value than weapons causing more permanent wounds to a much smaller number. Alternatively, in another situation, a premium may be placed on lethal or permanently disabling effects. Stated otherwise, are 10 casualties, losing 10 days each, equivalent to 100 losing one day each? The dilemma may be redefined as weighing immediate tactical advantage against a long term effect upon manpower.

The expenditure of ammunition by various military forces has been reasonably well recorded. It has thus far proven impractical, however, to relate a given expenditure of munitions to a given number of enemy casualties, much less relate them to a particular type of weapon. Nevertheless, penetrating wounds of the body surface have historically caused 90% of combat trauma injuries in land warfare (in the civilian sector, where blunt injuries predominate, penetrating wounds comprise only 25 to 50 per cent of trauma cases). Blast, burns, and blunt trauma account for the other 10% of injuries experienced in and combat. [In naval warfare, the predominant form of injury is thermal. During the Falklands war, for example, 34% of British naval casualties at sea were burns.]

In most conventional land wars, wounds caused by fragment penetrations have historically outnumbered bullet wounds. Wounds from explosive fragmentary munitions have accounted for between 44 and 92 percent of all surgical cases. Under circumstances where fragments predominate, and weapons cannot be aimed at particular body regions, missiles tend to be randomly distributed in space, and hits are a function of the frequency and extent to which the various regions of the body are exposed. Today, even terrorists may utilise explosive fragmentation devices that are as sophisticated as those used in modern warfare.

Under certain warfare conditions, the ratio of fragment to bullet injuries may reverse. During combat at close quarters, where ambush and sniping are frequent, directed fire may increase, and hits upon vital areas may be more frequent. These include military operations in urban environments; light infantry actions - such as Vietnam where 50% of the casualties had bullet wounds; low-intensity warfare; counter-insurgency actions; and jungle warfare. These differences in bullet versus fragment distributions are important to recognise since bullets are more likely to kill their victims than fragments from explosive munitions such as artillery shells or grenades (33 versus 10 to 20 per cent).

As a result of the ongoing perfection of a class of anti-personnel munitions known as fuel- air explosives (FAE), future wars will probably have even higher proportions of casualties with primary blast injury as well. In addition, if larger numbers of troops serve in armoured fighting vehicles, the proportion of burns in land warfare will also increase. Due to exposure of crew members to battle damage fires, burns have constituted an important component of wounds seen in the protracted armour operations of the past (20 to 40 per cent). Armour casualties may experience more than burn injuries, however. They are also prone to the combined impact of blast injury, toxic gas inhalation, and tissue wounds from both the penetrators of anti-armour munitions and the shrapnel fragments emanating from the defeated armour.

The nature of war wounds is always prone to continuing change with the development and use of new weapons systems. Innovations such as futuristic laser-charged particle beams and high-powered microwaves, for example, are now just beginning to demonstrate their impact as well.

Explosive Fragmentation Munitions: What Are They?
The prototype of the exploding munition is the shell. Originally composed of a hollow metal casing, explosive powder was packed within, along with a fuse for ignition. Depending upon the shell design, various kinds of fragments, projectiles, chemicals, or other agents were dispersed upon explosion. In older designs, fragments of the shell casing created most of the damage. Subsequently, artillery forces incorporated shrapnel to increase the antipersonnel effectiveness of explosive munitions. A shrapnel ball contained explosive as well as many small lead spheres (the shrapnel) packed in resin. Blasted out of the shell at detonation, the lead spheres greatly increased the number of projectiles from the explosive munition. Subsequently, more specialised modern exploding munitions evolved, such as hand grenades, rockets, bombs and mines.

Depending upon the size and design of the explosive munition, several thousand metal fragments may be produced upon detonation. Fragments radiating from the detonation site may retain their wounding potential for up to several hundred metres. Such munitions can also injure through blast and burning effects. A casualty close to the point of detonation of an explosive weapon, although extensively injured by the mutilating effects of a high concentration of fragments, may also sustain blast and burn injuries. Most of these casualties die immediately from multiple high energy transfer wounds, while some die from traumatic amputations caused by the dynamic blast over-pressure. The majority of the surviving wounded, however, these generally located distant from the explosion site, will have multiple, relatively low energy-transfer wounds caused by fragments of variable size with low impact velocities. At one British Army Hospital during the 1991 Gulf War, 81% of the casualties suffered from fragment wounds. An average of nine low energy transfer wounds were inflicted per patient!

Two antipersonnel fragment families exist; one older and "random", and the other modern and "improved".

Older ''Random" Fragmentation Munitions
The older fragment family is the product of detonation of artillery shells and large calibre mortar bombs. Natural fragmentation of the projectile casing results in fragments varying in size from dust particles to metal pieces weighing more than 1000 grams. Initial fragment velocities may be very high (as much as 1 500 to 1800 metres per second, but decline rapidly because of the poor aerodynamic characteristics of their irregular shape. Some fragments have a limited effective range and poor tissue penetrating power. Others, as a consequence of heavy mass and high kinetic energy, may penetrate deeply and cause massive damage. Because of their irregular shape and ragged edges, fragments produced by random fragmentation munitions often cause wounds with jagged shape due to the drag of the projectiles within soft tissues.

Improved Fragmentation Munitions
On future conventional battlefields, the majority of wounds will likely result from "improved" military fragmentation munitions (IFMs). The development of these newer improved munitions required a design in which the "shell" broke up into fragments smaller than those associated with random fragmentation munitions. In reality, the size of a fragment that will cause a casualty is surprisingly small - several hundred milligrams only! One of the earliest examples of the implementation of the IFM concept was the "pineapple" hand grenade of World War I (although some believed that this design characteristic resulted primarily from a desire to give the soldier a rough surface to grip).

IFMs designed post World War II usually incorporate etched fragmentation plates or notched wire fragmentation coils. Some IFMs are filled with preformed rods - hardened steel bits packed inside the munition, which are expelled when it explodes (a "canister shot", for example, is a shotgun-like container that can hold thousands of pre-formed rods or slugs).

Modern (improved) fragmentation munitions, such as contemporary hand grenades, small mortars and antipersonnel mines, contain either multiple uniformly constructed metallic spheres or aerodynamically fashioned dart-like arrow-shaped projectiles (flechettes), all of which have been designed for great penetration. Detonation of these munitions disperses a large number of such small pre-formed fragments. Weapons designers have expended considerable effort in producing a consistent fragment size, which offers an optimum compromise between range, velocity, probability of hit, and target wounding effectiveness. Their aim is to incapacitate by inflicting multiple low energy "transfer" wounds to areas not protected by modem helmets and body armour. Although the mechanical injury may be quite modest among surviving casualties who reach surgical facilities, many will have multiple wounds, often heavily contaminated with clothing, soil and skin.

An example of an improved conventional munition of the Vietnam era was the "beehive round", a 105 mm antipersonnel round filled with 8,800 flechettes. The flechettes were released from the shell at a time determined by the fuse setting, and their aerodynamic properties allowed them to pass through helmets and armoured vests more easily than irregular fragments.

Another improved conventional munition, the cluster bomb, acts as a cargo-carrying munition. It contains many small sub-munitions that in tum are filled with numerous small pre- formed fragments - the size and shape of which have been designed to cause a large number of casualties. Even more recent updates to this class of munitions are the US Army's Multiple Launch Rocket System (MLRS) munition containing 644 M77 submunitions, and the 155 mm Howitzer artillery projectile containing 64 M42 and 24 M46 submunitions. When a cluster munition is detonated, (either before or upon the carrier's impact), its submunitions or bomblets are disseminated over the surrounding terrain. When they explode, the fragments are dispersed over a much wider area than would have been affected if the same mass of potential fragments had been derived from a single thick-walled shell casing. The fragments of such weapons tend to be small and numerous, with the expressed purpose of achieving not only the high probability of a wound, but multiple wounds to each casualty. They are also fairly regular in shape, ensuring adequate range and consistent performance.

The most modern improved conventional munitions have combined antipersonnel with anti-materiel potential. The latter characteristic is obtained by incorporating a shaped charged warhead into each of the individual submunitions. When the munition detonates, fragments from the side walls are disseminated in a radial direction around the armour piercing jet produced by the shaped charge warhead. Such cluster munitions, incorporating dual purpose sub-munitions, were used with great effectiveness in the Persian Gulf war.

<u>Other Fragmentation Threats</u>

Following the surface or subsurface detonation of an explosive munition, secondary missiles are also produced from objects within the environment, such as dirt, rocks, trees, or debris from buildings. The nature of the secondary fragments is generally unpredictable. They tend to be irregularly shaped, with a wide range of masses and impact velocities, and may have considerable potential to cause injuries. In the aerial bombing of cities, for example, secondary missiles often cause the greatest volume of casualties. The wounds created by secondary missiles, however, may become badly contaminated. A landmine, for example, creates high-velocity secondary missiles from the ground in which it is buried. It is therefore likely that any severe wounds created will also be filled with dirt, pebbles and even chunks of plants.

The Wounds Created by Fragmentation Munitions

Penetrating missiles may cut, crush and lacerate tissues directly in the missile's path. When penetrating the skin, an antipersonnel fragment of low mass and low velocity causes an injury confined principally to the immediate track of the missile through the soft tissue. The visible passage created in the tissue includes the wound of entrance, and if it completely passes through the tissue, the wound of exit as well. These low energy transfer wounds arise simply from the cutting and crushing action of the projectile as it penetrates the tissues. Faster moving heavy missiles have more energy to transfer, and have the potential to cause more tissue damage. This damage is caused not only by direct contact between the missile and the tissue, but by tissue being violently thrown away from the missile's path through it. The radial stretching and tearing of tissue around the missile's track is known as "cavitation".

The impact velocity of a projectile can occasionally be a misleading indicator of its potential for injury. All projectiles cut, crush, bruise and displace tissues. Some projectiles, by virtue not only of speed but also their shape, may undergo a tumbling motion within the tissues. This induces further indirect injury to tissues not directly in their path. The radial or peripheral stretching and tearing induced by such projectiles, or "temporary cavitation", is variable, and is a consequence of increasing levels of transferred energy. The excess energy or fragment motion may induce merely a bruise around the missile path, or alternatively, a grossly explosive effect such as a shattering of the heart or skull radial to the missile path. Even if cavitation is not immediately lethal, its contribution to the occurrence of war wound infection is widely overlooked.

All war wounds are contaminated from the outset by soil, clothing, and skin. Fragments and any other projectiles with sharp irregular surfaces have been shown to cut clothing materials and skin efficiently, and also transfer notable quantities of these contaminants into wounds. Low-velocity projectiles regularly transfer such ragged pieces of clothing and skin contaminants into wounds. When the fragment velocity is raised and a temporary cavity is formed by the projectile, the nature of clothing contamination is further altered. Fibres and large pieces of material may be finely shredded and rapidly dispersed due to the formation of the temporary cavity, resulting in contamination of tissues far distant from the permanent wound track. If the temporary cavity involves the exit wound, substantial quantities of material may also be sucked into the wound from the exit hole, creating even greater widespread contamination, and the potential for infection at multiple sites.

Describing conditions in the Korean War, one historian noted:

> *"Even UN soldiers arrived in hospitals with most wounds ... grossly contaminated with field dirt, leaves of rice plants, and crumbs of human excrement plainly visible in some of them. Wounded North Korean prisoners of war showed the same problem in exaggerated form, their injuries frequently infested with hordes of maggots."*[1]

Bullets and their Wounds

Both the design and construction of a bullet determine the kind of wound created. The wounding effects of deforming hollow point and soft-nosed hunting ammunition, for example, which change shape after penetrating tissue, are noticeably different and potentially more devastating than those of non-deforming bullets. Most bullets are long and thin and are spun along their long axis to provide stability and accuracy. After entering soft tissue, however, spin stabilisation is overcome and bullets become unstable. They may tumble and turn through 180 degrees, thus increasing the surface area of tissue presenting to the forward-moving missile. This results in significantly greater tissue damage. If the wound track through tissue is long enough, all bullets will tumble. As a bullet tumbles, it may become deformed or break up - especially if it contacts hard high-density bone.

Bullet wounds in the battlefield are generally caused by fully jacketed military ammunition as defined by the Hague Declaration of 1899. The latter prohibited the use of any "bullet which expands or flattens easily in the human body". To meet this requirement, bullets designed for military use are comprised of lead and steel components clad within a metal jacket. As a result, it has been suggested that designers of military small arms, ostensibly formulating bullets to prevent flattening deformity of the missile, use alternatives such as bullets which readily fragment in order to cause equivalent tissue effects.

Even if not designed as such, many bullets may nevertheless fragment at close range if they strike bone. The tendency to break-up is governed by the construction of the bullet, principally the thickness of the jacket and the efficiency of the base in preventing extrusion. The disruption of the bullet into small pieces produces irregular fragments, each with large potential for energy transfer. A temporary cavity around the fragmenting bullet will be associated with multiple diverging wound tracks. Multiple lacerations of the tissues surrounding the original wound track are the result. If the victim's skeleton is damaged by a missile as well, the fragmented bone may provide an even larger number of secondary fragments. When scattering bone fragments are combined with bullet fragmentation, widespread disruption of soft tissues is produced within the vicinity of the bone including any adjacent blood vessels, nerves and other soft tissues.

Blast Injuries from Fuel-Air Explosives

An explosive munition, on detonation, produces a transient pressure that can propagate through the air at an initial velocity exceeding the speed of sound. It may rupture eardrums and severely bruise and rupture both the lungs and other gas filled organs (such as the intestines), leaving no tell-tale external marks on the victim. Very high overpressures can also cause air to be pumped into a victim's circulation, causing dangerous and often fatal air embolism of the heart and cerebral blood vessels. It can also liberate fragments of debris from the environment that may act as penetrating missiles. Furthermore, the mass of moving blast wind may forcibly blow the casualty against solid objects in the area, thereby inducing blunt injury as well.

A typical Fuel-Air Explosive (FAE) consists of a cylindrical container of a liquid fuel, such as ethylene oxide or propylene oxide, the walls of which are scored so that the container can break apart in a controlled manner. It also contains a burster charge located at the center, which extends along the long axis of the container. When the burster charge detonates, the contents of the fuel container will be dispersed as a mist-like disk-shaped fuel-air cloud over the ground. It flows around objects such as trees and rocks, and into structures or field fortification ventilation systems. Next, a small secondary charge ignites the fuel-air mixture. The vast dimensions of the FAE cloud ensure that the blast effects will occur over a much wider area than that affected by any conventional explosive munitions. The FAE blast wave can go around corners, penetrating the apertures in bunkers, the open hatches in armoured fighting vehicles, and the hollows of trenches and foxholes. In Afghanistan, such FAE munitions labelled vacuum bombs, comprised a significant proportion of the munitions dropped by Soviet aircraft. Since the Vietnam War, FAE weapons have been improved so that their blast effects now rival that of a small tactical nuclear warhead.

Other Military Specific Injuries

There are other mechanisms of injury predominantly confined to the military spectrum. These include burns from napalm, incendiaries, flame munitions, and white phosphorus. Crush injuries also occur in greater abundance in the military setting. The implications of crush injury extend to needed repair of skin, bone, muscle, blood vessels, and nerves, as well as the possibility of treatment for kidney failure, a common result of this form of trauma. In addition, military inhalation injuries may result. These occur from breathing the byproducts of ammunition and plastics combustion, and inhalation of particulate metallic aerosols (such as "chaff' which may be released to cloud electromagnetic transmissions of attacking missiles). Other inhalation injuries result from the breathing of rocket fuel combustion fumes, and environmental obscurant agents such as picric acid and anthracene all common to the modern battlefield, with few equivalents in peacetime.

Implications for Delivery of Medical Services

Most peacetime models and experiences are of limited value when preparing medical officers for service in the combat setting. Many of the enormous peacetime technical advances in modern surgery those which have transformed the outlook for patients born with congenital abnormalities, or those suffering from such degenerative conditions as arthritis, heart disease, and cancer do not have immediate application on the battlefield! The wartime phenomena of large numbers of casualties which are generated simultaneously, many bearing multiple wounds and concurrent injuries from the entire spectrum of militarily unique weapons, are not ordinarily seen in peacetime medical practice. They differentiate and complicate casualty management in the military medical field system. As a noted authority in combat medical care once noted: "The practice of medicine and surgery in peacetime prepares physicians for war as well as police department duty would prepare infantry for combat, or as well as commercial aviation experience prepares pilots for close air support in wartime".[2]

There are undeniably fundamental differences, oftentimes forgotten, between medical treatment practices in peacetime and those employed in war. Indeed, the very nature of warfare precludes a neat transformation in place from such successful peacetime models of healthcare. These are best exemplified by two contrasting hypothetical examples:

- In the peacetime setting, a victim of urban violence who sustains a perforating soft tissue wound of the thigh by a 9 mm pistol bullet, is often rapidly transferred by emergency medical services, within minutes, to a civilian trauma hospital designed to provide a full spectrum of needed care. Within these centres, in response to multiple demands of such nature, effective treatment methods have evolved. These efforts are commonly supported by the general availability of teams of multi-disciplinary consulting specialists, buttressed by sophisticated medical imaging techniques such as CT scanning and NMR (nuclear magnetic resonance) scans. The most modern broad spectrum antibiotics are often administered within minutes of wounding. Finally, there is access to well staffed intensive care units, where changes in patients' conditions can be intensively followed for days and weeks, often without time limits.
- A military rifleman, recently sustaining a similarly located thigh wound following the nearby explosion of a rocket propelled grenade, perhaps complicated by blast injury to his lungs and white phosphorus burns of his torso, lies in a muddy field heavily contaminated with human and animal wastes elsewhere across the globe. Because of tactical and logistical limitations, the soldier may have remained in that muddy field for many hours before being retrieved, causing his general condition to worsen, and bacteria in his wounds to multiply. He may then be deposited, with a group of other bleeding wounded, at a military evacuation hospital which is so busy that only 5 minutes can be allotted to the immediate care of each casualty. Subsequently, he may be entered into a protracted evacuation chain entailing temporising increments of treatment. This process may involve multiple transfers and the passage of a significant amount of time until arrival at a definitive care facility.

The contrast between the two hypothetical examples is self evident, yet directly relevant to the unique characteristics of the professional practice of military medicine in the operational setting. Indeed, the historical record readily confirms that military physicians must periodically provide their treatments in such a setting of physical and logistic austerity as denoted in the second example, and further carry them out in the incremental or echeloned fashion typical of military field medical systems. These require medical judgements far removed from those utilised in peacetime!

Unfortunately, military surgeons have traditionally received their indoctrination to wartime surgery by "on-the-job training" within the combat zone. In contrast to clinical practices during peacetime, surgeons have had to become reoriented to various historically validated special techniques for rendering rapid but often only "adequate" care to victims of massive military wounds and massive trauma. US Army surgeon Captain Richard Hornberger of the 8055th Mobile Army Surgical Hospital (MASH) in Korea, speaking as Richard Hooker, the pseudonymous author of M*A*S*H, provided meaningful perspective on this one phase of reality during the early surgical reception of combat casualties:

> *"Meatball surgery is a specialty itself. We are not concerned with the ultimate reconstruction of the patient. We are concerned only with getting the kid out of here alive enough for someone else to reconstruct him. Up to a point we are concerned with fingers, hands, arms and legs, but sometimes we deliberately sacrifice a leg in order to save a life, if the other wounds are more important. In fact, now and then we may lose a leg because if we spent an extra hour trying to save it, another guy in the preop ward would die from being operated on too late. . .. Our general attitude around here is that we want to play par surgery on this course. Par is a live patient'.*[3]

Summary

Sustainability during combat operations is a paramount concern of every operational commander. His judgements will often determine whether his war-fighting concepts and plans are supportable. Since health maintenance and casualty management programs are crucial underpinnings of any operational plan, the structure and operation of combat medical services must be thoroughly integrated with tactical operations. Therefore, the decision for a specific form of supporting activity in any given manoeuvre, such as medical support, is ultimately the commander's responsibility!

As a commander weighs the various benefits and tradeoffs associated with a combat casualty support program, he must also assess the cost of such support in terms of the competing demands of an essentially logistical function for portions of his offensive assets, as well as their impact upon his tactical mobility. For these decisions, the operational commander is beholden to his medical staff for informed advice. The inherent differences between wounding agents, as well as the unique logistical requirements for management of combat-unique casualties, within a setting of austerity and restricted support, must therefore be clearly recognised - not only by professional medical authorities but by the line commanders who depend upon their counsel and support.

The ground rules for practising the precepts of combat medical support differ from those utilised in peacetime military medical practices. It is therefore incumbent upon medical officers to become well-informed resources for their operational counterparts. An understanding of weapons effects is an important facet of that required knowledge base, in order to facilitate a functional transition from the procedures and expectations of peacetime medical practice to the realities of combat.

References

1. Cowdrey AE. The Medic's War. The US Anny in the Korean War Series. Vol4. *Center of Military History, US Army*, 1987:p87
2. Llewellyn CH. Education and training for war surgery. *Mil Med* 1990; 155:192
3. Hooker, R. "M*A*S*H". New York, Wm. *Morrow & Co*, 1968: pl88