CINCPAC WAR SURGERY II

COMMANDER IN CHIEF PACIFIC
SECOND CONFERENCE

ON

WAR SURGERY

JOHN HAY AIR BASE
PHILIPPINES

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25-28 MARCH 1968

COMMANDER IN CHIEF PACIFIC
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Subj: Commander in Chief Pacific Second Conference on War Surgery

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Encl: (1) Proceedings of CINCPAC Second Conference on War Surgery

1. The Second Conference on War Surgery sponsored by CINCPAC was initiated by reference (a) and was held 25 - 28 March 1968. Its purpose was to review and assess the techniques of resuscitation and surgical treatment used in the care of U. S. casualties and to provide recommendations to aid those treating war trauma.

2. Many casualties, especially the more extensively wounded, receive part of their care in each of the three distinct geographic echelons of hospital treatment:

a. In-country (Vietnam) Hospitals.

b. Pacific Command Hospitals outside Vietnam.

c. CONUS Hospitals.

While each echelon has many outstanding surgeons, and there are a few individuals who have worked during this war at two or even three echelons, those at the first or second level rarely learn how their specific or types of treatments have turned out at the next echelon. Similarly, those at CONUS and PACOM levels cannot always appreciate the problems and options presented the in-country surgeon. These CINCPAC conferences are felt to more closely coordinate treatment at the three echelons and promote improved patient care.

3. The Departments and PACOM Component Commands were requested to send as conferees a strictly limited number of surgeons presently at full time duty providing surgical treatment to casualties from

Vietnam. This group was given the task of defining a consensus position in all areas of surgical treatment of war casualties. They developed the professional guidance reported in enclosure (1).

4. The senior conferees remained several days following the termination of the conference editing the enclosed report. The recommendations of each surgical specialty are in accord with those of every other specialty reported. The objective is not to produce a carefully edited and commercially published volume. Such a volume would be, in considerable part, out of date by time of availability. Rather it is intended this less smooth document be made available as early as possible for guidance of working surgeons and be subject to modification by a new set of proceedings following similar conferences every six to eight months or as indicated.

5. In consonance with the concept of continual updating to disseminate new experience, the CINCPAC Third Conference on War Surgery is planned for the fall of 1968. The Surgeons General and the Pacific Command Component Commanders in the near future will be asked to nominate attendees.

6. These proceedings are made available to the Departments and Commands for use as they see fit in furthering the professional care of casualties. Additional copies may be obtained upon request to the Commander in Chief Pacific.

J. S. COWAN
Medical Officer

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CINCPAC SECOND CONFERENCE ON WAR SURGERY

John Hay Air Base, Philippines

25 - 28 March 1968

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FOREWORD

Perfection is attained not by doing extraordinary things but by doing ordinary things extraordinarily well. So let this apply to the care of our battle casualties.

Our goal is to record here the methods of choice in treatment of combat casualties which we feel, based on experience to date with casualties from Vietnam, will result in the greatest number of wounded being rehabilitated in the shortest and safest manner with the least residual disability. It is not our intent to point a finger at any individual, unit, or service. We want the facts to speak for themselves.

Lest we become complacent or rigid in our thinking we must periodically evaluate and reevaluate the results of our treatment. This must be done in an honest and realistic manner so that we may render objective opinions and constructive criticism. If the reader will realize this he will then be able to accept our recommendations in the same manner in which they are being given.

We submit that the human body reacts to injury and standard surgical procedures in a predictable manner. The variable factors are the experience and judgment of the surgeon, the environment in which he and the patient are placed, and the workload that the surgeon is forced to accept.

It is hoped that by reading and understanding the basic concepts of battlefield surgery, the combat surgeon will both apply and intelligently modify them to fit the circumstances in which he finds himself.

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SUMMARY

The group met in a most congenial and cooperative manner so as to make most effective use of their talent and experience.

In general this conference has confirmed that the basic concepts of war surgery remain unchanged and that the impressions of last year's conference have stood the test of the past year. The only difference brought out has been the inability to apply the ideal treatment in all situations.

A plea is made for better records and better indoctrination of the newly arrived surgeon. It is also requested that no commitment of disposition of the patient be made so as to avoid misunderstandings by the patient and his family.

The group advances the following topics for consideration of further investigation:

1. Delayed primary closure as to best timing and technique
2. Initial wound dressing comparison
   a. Wet

      Saline, antiseptic or antibiotic

   b. Dry
   c. Type of material
3. Antibiotic coverage regimens, if any
4. Sepsis, especially Gram negative
5. Shock
6. Bleeding diathesis
7. Stress ulcer
8. Pulmonary complications at each echelon
9. Genitourinary tract wounds
10. Incidence and significance of various wounding agents
11. Ways and means of exchanging results and encouraging clinical investigation at all echelons

It is agreed that these meetings should continue every 6 to 8 months and that firm selection of attendees be made 3 or 4 months or more prior so that data can be properly collected.

The keynote of this conference has been Surgical Judgment in the Field.

AEROMEDICAL EVACUATION

The first and most readily apparent new factor affecting the medical care of battle casualities occurring in the current Southeast Asia conflict is the marked reduction in the time lapse from injury to initial first aid, from first aid to competent resuscitation care, from resuscitation to first stage specialty surgical care, and finally, to definitive surgical care and rehabilitation and the return of the casualty to productive life.

Time tested surgical principles, new techniques, new instruments and advanced technology, new and improved medications, and rapid dissemination of knowledge and experience are applied to each stage of the care of the injured patient.

The almost shattering effect of the rapid transportation of the human body through time zones and hemispheres of the earth has been experienced by many normally healthy persons during the "jet and space age." Never before the present conflict has this effect been applied to the seriously injured human nor has it been faced by the patient's attending surgeons. At this writing it is apparent that the patient has tolerated the effects of the jet age quite well and his chances of recovery have been improved. However, the medical profession must appreciate the significant modifications in patient care implied by the introduction of rapid patient transportation. It is to aid in this appreciation that this chapter is presented.

Throughout all sessions of this conference the various surgical specialties recognized the requirement for decision making in patient care related to the very early appearance of the casualty at each stage of care from time of injury to eventual recovery. Certain aspects of aeromedical evacuation are applicable to all patients and these and general information are presented below.

Factors applicable to specific surgical specialties or to specific injuries are presented under separate headings.

I. GENERAL DATA

1. Unscheduled and short distance medical evacuation within a combat zone is accomplished by a wide variety of rotary and fixed wing tactical aircraft. In most instances medical capability is limited to first aid and aircraft are utilized to provide rapid transfer to an area having first line resuscitation capability.

2. Currently, both scheduled and unscheduled aeromedical evacuation from South Vietnam to medical facilities in PACOM or CONUS originate at the airfields of Tan Son Nhut, Cam Rhan Bay and DaNang. Casualty staging capability exists at each of these three ports and normally all patients entering the evacuation system are processed through these facilities. Flight Surgeons, nurses, trained technicians, as well as standard medical equipment and supplies, are provided at each port.

3. First-step ports within PACOM currently in use are at Clark Air Base, Philippine Islands and Yokota, Japan. Casualty staging facilities (medical staff, equipment and supplies) are provided at each port. At Clark AB the casualty staging facility is a part of the general hospital complex on the base. In Japan, the staging facility will remain at its present location near the general hospital at Tachikawa AB pending completion of a new facility at Yokota.

4. Patient transfers through Clark may be to Japan, Guam, Hickam or to Travis AFB, California for CONUS destinations. Patient transfer through Yokota may be to military hospitals within Japan, or to CONUS via Elmendorf, Alaska to areas east of the Mississippi River, and to Travis for hospital destinations west of the Mississippi River.

5. First stop CONUS patient transfers process through staging units having general hospital support at Travis AFB, California, Scott AFB, Ill., or Andrews AFB, Maryland.

6. A scheduled special "Burn" flight departs Yokota each Monday via Travis for Kelly AFB, Texas for transfer to the Burn Center at Brooke General Hospital. Burn patients for this flight are processed through the Burn Stabilization Unit at the Army General Hospital in Japan. Burned patients requiring special care originating in Southeast Asia are referred to the 106th Hospital via scheduled and unscheduled air-evacuation flights departing from one of the three main ports in RVN. An attending surgeon for flights out of RVN is on an on-call basis. Each special flight from Japan to the Burn Center at Brooke General Hospital has a "burn team" (including a surgeon) from the center accompanying the flight through to Brooke General Hospital. Navy/Marine burn patients receive care in the CONUS Navy Hospitals.

7. Patient destinations within PACOM and CONUS are normally determined by a joint regulating office (JAMRO or ASMRO) and not by the various casualty staging units. Patients may be removed from the evacuation system at any port en route when it is the professional opinion of the evaluating surgeon that patient safety will be compromised by continued transfer, whether by surface or air.

8. The current aircraft utilized for long range, high altitude air transfer is the C-141. It is pressurized to maintain a cabin altitude of

6 to 8,000 feet. When utilized for medical evacuation it is configured to provide litter capability and has individual patient oxygen support as required. Combinations of ambulatory and litter patient transfers are normally for approximately 60 patients per flight. Higher numbers are possible; however, when more then 30-40 litter cases requiring nursing attention are placed on one mission, an augmentation of the normal two nurse, 3-4 technician team may be desired.

9. The only aircraft specifically designed for aeromedical evacuation and thus having all capabilities normally considered available for nursing care of any patient is the newly acquired C-9 jet. This aircraft will appear in the aeromedical system this year. Currently, all aircraft, conventional and jet, in use as a method of patient transfer are military aircraft designed for cargo or troop transportation. Re-configuration and provision of equipment and supplies for patient care is necessary for proper and safe patient care. This is accomplished as practical and possible with due consideration for the impact of tactical requirements and circumstances.

II. SPECIAL

1. Tracheostomy care: Tubes should be of proper size. When the Bird respirators are to be used the tubes should be cuffed (double if desired). Due to the very low humidity of aircraft cabin atmosphere, the use of the "artificial nose" is essential to avoid the production of dry mucous plugs and to insure proper tracheal care and toilet during flight. (Also see anesthesia Section)

2. Cranial Tongs: Special attention should be paid to the proper seating of the tongs. Traction must be maintained by a closed system, preferably with the Collins' spring. In the absence of a spring device, traction may be maintained by heavy rubber tubing. Weights, hanging free, must not be left attached during flight to prevent sudden jerking upon the tongs. (also see neurosurgery section)

3. Skin traction: A closed system of plaster, wire loop, and stockinette glued to skin will provide continuous traction to amputation stumps if there is use of a rubber tubing from the stockinette to the loop. Weights must be removed during flight to avoid sudden tension upon the skin. (also see orthopedic section)

4. Chest tubes: Tubes may be left in position during aeromedical transfer, but must be equipped with a functioning valve, preferably the Heimlich valve. Should chest tube be removed, air transfer must be postponed for 72 hours and a chest x-ray should be taken and reviewed prior to transfer. (also see thoracic surgery section)

5. Naso-gastric tubes: All patients requiring N/G suction at ground level must have such protection during flight. The combination of the basic medical problem, air swallowing due to anxiety and pain, and reduced barometric pressure at altitude could result in difficulties during flight. Abdominal pressure under a body cast, pain from distention of hollow viscera, and most importantly, vomiting and aspiration with serious pulmonary complications often result. (also see anesthetic, burn and neurosurgery sections)

6. Plaster casts: The understandable requirement for immobilization of extremities using circular plaster casting invites serious difficulty during flight unless casts are bi-valved or mono-valved. The practice of placing inscriptions and diagrams on plaster casts is especially important during transfer from one facility to another. Dates of injury, surgery, cast applied, and sketches of bone injury provides a rapid means for careful patient evaluation. (also see orthopedic, debridement and vascular sections)

7. Vascular grafts: Grafts, both vein and prosthetic, require special attention at ground level (immobilization, etc.) and due to pressure changes at altitudes, deserve special attention during transfer. Casts must be windowed over graft areas to provide rapid access should bleeding occur. When tactical situations permit, graft cases should not be transferred until 21 days post-repair. To insure flight nurse attention, cases transferred should have the repair date inscribed on the cast or dressing.

8. Stryker frame: Portable frames are available for long distance transfers by air. Patients will be turned during transfer as directed by the referring surgeon.

9. Catheter care: In-dwelling catheters in use prior to transfer should be left in place during transfer. Instructions for specific care en route (both staging areas and in-flight) will be accomplished if made known to the medical teams along the route.

10. Circulating blood volume: Oxygenation problems at ground level will be increased at higher altitudes. Patients having hematocrits of 30% or below should not be transferred under any but the most urgent tactical situation, and, if transfer must be accomplished, proper supplies for transfusion should accompany the patient along with orders for the use of blood requirements while en route. (also see anesthesia section)

11. Cerebrospinal leak: A wound draining cerebrospinal fluid at ground level will drain slightly faster at higher altitudes. These wounds are not a contraindication for transfer if such is desired for other reasons.

12. Medications: Certain medications, especially antibiotics, should have a recorded "stop order" to avoid an undesirable extension of the intended course of therapy. Certain medications are not normally in standard supply and when these are to be continued during patient transfer, an adequate supply must accompany the patient.

13. Burn case care: Burn patients may be transferred at any time during their care; however, as in all severely wounded patients, transfer is unwise unless and until the patient is relatively stable regarding the cardio-vascular-pulmonary systems. Burns greater than 10% TBS should be transferred from Vietnam to PACOM. Burns greater than 40% should have a surgeon in attendance unless the burns are partial thickness and the patient is well stablized. Smaller burn areas, but with associated severe injuries may best be transferred with a surgeon in attendance. Preparation for transfer should include:

a. Functioning intravenous pathway.
b. Adequate urinary output.
c. Functioning airway (endotracheal tube or tracheostomy as required).
d. Wound coverage via the two sizes of field compresses (available in Vietnam).
e. Record of surgical procedures, fluid in-put, urinary output.
f. Naso-gastric tube in place and functioning (ileus is common in burns over 20%) especially in comatose patients.
g. Immobilization of associated injuries.

(also see Burn Section)

COMMENT

A thorough understanding of the values and technical limitations of aeromedical evacuation systems has provided and will provide the combat surgeons and other military medical specialists a means of further reducing the mortality and morbidity of battle casualties.

ANESTHESIA

INTRODUCTION:

Discussion was initiated in general terms amongst the representatives from Vietnam and from the PACOM hospitals. After preliminary discussion of the anesthetic management of the seriously wounded patient, it was determined that patients in PACOM hospitals had anesthetic problems comparable to those met in the day-to-day practice of anesthesiology in CONUS. Therefore, it was decided to orient this presentation primarily toward the anesthetic problems encountered with the acute casualty in Vietnam.

Anesthesiology has made many advances in the resuscitation and anesthetic care of casualties in Vietnam as compared to previous conflicts. The advent of new drugs, anesthetics and equipment have all contributed. The availability of better trained personnel in more adequate numbers has certainly been a prime factor. Evacuation, primarily by helicopter, of the combat casualties directly to medical facilities capable of providing definitive care has resulted in the sparing of lives and reduction of morbidity.

Upon the casualty's arrival in the triage area in Vietnam hospitals, the surgeon immediately evaluates the extent of his wounds, and orders appropriate x-ray and laboratory work. The casualty is also evaluated by the anesthesiologist for any respiratory or cardiovascular difficulties. Those casualties who respond to resuscitation are then selected for surgery on the usual priority basis. It is this new concept of resuscitation by the anesthesia-surgery team which has produced the highest survival rate recorded in armed conflicts.

Since most of the primary treatment facilities are now in a controlled environment namely, M.U.S.T. units, quonset huts, permanent buildings or hospital ships, it has been possible to replace the antiquated equipment of the field type left over from World War II. Modern and safe anesthesia machines are an absolute necessity if the more seriously wounded are to survive. It is recommended that each anesthesiologist reporting to any unit in Vietnam should survey available equipment and what his requirements for new replacement items will be. He must consider the necessary lead time in the supply line and anticipate usage rates in maximum work periods. Additionally, he must realize the necessity of ordering new equipment and supplies to replace that which deteriorates more rapidly in an environment which markedly affects both the operation and life expectancy of the anesthesia and inhalation therapy equipment. Much of the equipment and many of the drugs now used in the specialty of anesthesia

are new. Some are still too new to have been placed on the standard supply tables. These items must be specially purchased on the open market as non-standard items if the casualty is to be provided the outstanding anesthetic care to which he is entitled.

TECHNIQUES:

The majority of patients undergoing surgery in Vietnam are now anesthetized under general anesthesia. This is usually accomplished by a thiopental-type induction and maintenance with halothane, nitrous oxide, and oxygen. This technique with or without relaxants has been the method of choice in most cases requiring general anesthesia. With the advent of new field equipment, the advantages of halothane in a combat zone include its rapidity of induction, ease of administration, non-explosiveness and applicability to most casualties. In addition, it should be stated that the rapid emergence from anesthesia and lack of nausea and emesis postoperatively reduce the requirements placed on personnel of the surgical intensive care unit. In those cases requiring relaxants, it is strongly recommended that only small quantities of curare or succinylcholine be employed. A succinylcholine drip is not recommended, primarily because of danger of overdosage in a busy combat hospital. Secondarily, the available intravenous routes are frequently being utilized for rapid infusion of blood and electrolyte solutions.

Penthrane has been infrequently used. Ether and cyclopropane have little role in the anesthetic management provided in Vietnam primarily because of explosability. Additional drawbacks of these agents are well documented.

Spinal anesthesia for the field casualty is limited to patients with isolated wounds of the legs, buttocks or perineum, not associated with other injuries. It is to be emphasized that when spinal anesthesia is to be utilized, the anesthesiologist must evaluate the pre-anesthetic status of the cardiovascular system very carefully. Battle casualties, especially during the summer months, are dehydrated. Blood loss prior to admission is difficult to assess. Blood pressure and pulse may or may not aid in the evaluation. The hematocrit values in such patients may be misleading because many of the casualties will demonstrate hemo-concentration secondary to dehydration. The amount of blood lost must not be underestimated in the casualty who appears to have only a minor wound.

Brachial block is the only other frequently used regional technique in the management of the field casualty. This technique has been found to be very satisfactory for the isolated upper extremity wound.

Local anesthesia should be limited to those patients who have small, noninfected wounds which can be adequately debrided with this technique. The published maximum dosages of agents should not be exceeded. More

extensive injury dictates regional or general anesthesia for adequate surgical debridement. Casualties, who undergo surgical procedures utilizing block or local anesthesia techniques, require the same careful monitoring, and the intravenous administration of electrolytes and blood, as those who are given general anesthesia for similar procedures. Fatigue, dehydration, and moderate unrecognized blood loss are common in these patients. Large doses of local agents combined with morphine administered in the field, can lead to chronic hypoxia and eventual progression to shock and cardiac arrest. Too often, in a busy casualty receiving unit, these patients who have regional or local anesthesia are placed in an overflow ward postoperatively rather than in a surgical intensive care unit. Observation in such a ward is often less than adequate.

PROBLEMS ENCOUNTERED IN FRESH CASUALTIES FROM THE ANESTHESIA VIEWPOINT:

HYPERTHERMIA:

Temperature should be checked on admission. Hyperthermia is extremely common in casualties in Vietnam. Elevated temperatures are often due to the combination of heat and dehydration, malaria, and/or infections secondary to delay in transport from the field. Febrile patients should be cooled toward normal temperatures as rapidly as possible and preferably before an anesthetic is administered. Equipment to induce hypothermia is considered an absolute necessity in the management of these patients during and following surgery in field hospitals in Vietnam.

GASTRIC DILATATION:

The problem of acute gastric dilatation in the wounded is a very common occurrence. It is seen even in patients with minor wounds. It is probable that a combination of fear, pain, and air transport contribute to gastric dilatation. Forceful intermittent positive pressure breathing during resuscitation will compound this problem by pumping air into the stomach. The liberal usage of nasogastric tubes is to be encouraged. The distended stomach has deleterious effects on respiratory function and may be a contributing factor in cardiovascular collapse during surgery or in the postoperative period.

FLUID AND BLOOD REPLACEMENT:

ROUTES OF ADMINISTRATION:

In the severely traumatized casualty where multiple wounds exist and blood loss has been extreme, several intravenous routes should be immediately established. Large gauge Rochester-type

needles are recommended (Jelco or Angiocath). With the type where the polyethylene tubing goes through the lumen of the needle, experience has shown that leaks occur at the site of puncture when blood is infused under pressure. This type frequently perforates the vein unbeknownst to the anesthesiologist. The extremity then becomes swollen, distended and useless as an avenue for intravenous therapy. These patients also should have a catheter placed in the external jugular vein and threaded into the superior vena cava for monitoring central venous pressure. An alternate lead for central venous pressure monitoring is via veins in the upper extremity. When cutdowns are necessary, it is recommended the superficial femoral or the upper extremity veins be utilized. It has been found that cutdowns in the ankles do provide an avenue for adequate fluid therapy, but it is difficult to administer blood under pressure through this route. The veno-tube with a 3-way stopcock works extremely well as a catheter for cutdowns. Its large bore (approximately 12 gauge) accepts massive volumes rapidly. In patients with major wounds of the abdomen and pelvis, only the veins of the upper extremities and neck should be utilized. This will avoid the possibility of extravasation of transfused blood into the traumatic area. The intravenous route through the subclavian vein has been utilized with increasing frequency during the past year in Vietnam. At this conference there has been reported an alarming number of complications associated with this technique. The complications recorded and documented are as follows:

1. Hemothorax
2. Pneumothorax
3. Postoperative paresthesias in the extremity on the involved side.
4. A reported death in a Vietnamese casualty who had an arrest while under general anesthesia secondary to an unrecognized tension pneumothorax.
5. Because of these complications, it is recommended that the subclavian route not be utilized except in the most desperate situation.

MASSIVE TRANSFUSION

In patients who require massive transfusion (10 units or more) where oozing maybe a major problem, it is recommended that at least 1 unit of fresh blood be given after every 8 to 10 units of bank blood. In many Vietnam facilities fresh blood is utilized for this purpose fully realizing that there is a

potential hazard of hepatitis or malaria being contracted from the donors. Where available, fresh frozen plasma is better used for the control of oozing. Fresh frozen plasma contains no platelets but is free of the danger of hepatitis. The value of the use of calcium, vitamin K, or protamine in patients, where oozing is a problem, is controversial. Clinical impression is that these drugs appear to do some good in specific instances. In many hospitals in Vietnam, the use of 1 ampule (44 mEq) of sodium bicarbonate for every 3-5 units of blood is routine. Studies have shown that most patients who arrive in hypovolemic shock secondary to massive trauma are alkalotic rather than acidotic. The recommendation is that sodium bicarbonate not be utilized early in the treatment of these cases until the alkalosis has been corrected.

Patients coming from the field may have received low titer O positive blood. If less than four units have been given, it is recommended that type specific blood be used after appropriate crossmatch. If four or more units have been given, the consensus of the conferees was that low titer "O" blood should be continued.

Massive blood transfusions require that blood be warmed during administration to avoid adverse effects on the cardiovascular system. Blood Warming Coil should be available in all units where the severely traumatized patient is being treated.

Overtransfusing does occur although infrequently. When suspected, prompt diagnosis should be established by physical signs and symptoms and/or central venous pressure determinations. Under continuous central venous pressure monitoring, therapy consists of phlebotomy, intermittent positive pressure, and digitalization if indicated. Under-transfusion is the usual problem and the condition is aggravated in the immediate postoperative period by oozing from raw surfaces. In the severely wounded patient, central venous pressure, urinary output, vital signs, and clinical evaluation of the patient are the minimal criteria to be used as guidelines for the rational use of blood. Except when mass evacuation is required, these patients should be retained at the initial treatment facility for a minimum of 24 to 48 hours to stabilize their cardiovascular systems. It is strongly recommended that patients who are evacuated out of country have stable repeat hematocrits prior to transfer. As a practical guideline, patients who have an hematocrit of 30% or below should be transfused with sufficient blood to bring their hematocrit value to 35%, provided other parameters are within acceptable limits.

AIRWAY MANAGEMENT:

The anesthesiologist and the nurse anesthetist at all levels of field care should continue to teach the proper use of equipment and techniques for respiratory resuscitation. Some casualties arriving from the field have been noted to have poorly or dangerously placed tracheostomy tubes. These tracheostomies have almost always been performed by inadequately trained personnel attempting heroic measures. Many of these patients would have been better served by proper positioning of the mandible and/or insertion of an oral or nasal airway. Patients on arrival in hospital triage areas can be treated for respiratory distress by the immediate insertion of either a naso-tracheal or oro-tracheal tube. In casualties without direct involvement of the airway or where adequate ventilation may be restored within several days (3-5), the endotracheal tube should be used rather than a tracheostomy as the first approach in airway resuscitation.

In patients who require tracheostomy because of severe head or neck wounds, the initial use of a nasal or oral endotracheal tube will convert the procedure from an emergency to an elective one, performed under controlled conditions.

In the management of respiratory problems devolving upon the surgeon-anesthesiologist team, tracheostomy is recommended in the following instances:

1. Where adequate tracheobronchial toilet must be accomplished to prevent complications of the already compromised pulmonary system.

2. In the comatose patient where aspiration of vomitus is a potential problem.

3. In patients who will require prolonged respiratory assistance in the postoperative period and during evacuation out of country.

4. In the severely traumatized patient, where either the danger of aspiration or the need for assisted ventilation and/or anesthesia exists, a double-cuffed tracheostomy tube, adaptable to both resuscitative and anesthesia apparatus, should be used.

All patients in the evacuation system with tracheostomy tubes or artificial airways should be fitted with an "artificial nose" during transport. These devices will humidify inspired air to 80% of the value obtained by normal breathing at sea level. This piece

of equipment is reasonably priced. Information on one source of supply is: The Garther Vapaur Condensor
Harris Calorimic Company
Medical Division
5501 Cass Avenue NW
Cleveland, Ohio 44102
The approximate price of this apparatus with a condensor and six elements is $26.50. The six elements separately cost $2.50.

USE OF ANTIBIOTICS ASSOCIATED WITH RESPIRATORY DEPRESSION:

Attention was directed to the respiratory problems noted after the use of Kanamycin or Neomycin solutions for lavage and/or instillation into body cavities. Cases were presented by the surgeons in which apnea and/or respiratory depression had occurred. It was recommended that caution be employed in the use of these and similar drugs and that these drugs be employed in low concentrations and dosages to decrease respiratory complications.

RESPIRATION AND INHALATION THERAPY:

A significant number of casualties have serious pulmonary problems in the postoperative period. Some of these patients die from these respiratory problems if adequate, intensive respiratory care is not instituted. Assister-controller type respirators are readily available in Vietnam and these machines are used extensively. However, they cannot adequately ventilate the patient who has decreased pulmonary compliance and increased airway resistance resulting from severe trauma to the lungs. The consensus of this panel is that a volume-limited respirator rather than a pressure-limited respirator is more effective.

The recommendation is made that all mechanical resuscitators be deleted from our armamentarium. They have proved to be ineffective in emergency airway resuscitation. It is recommended that they be replaced by a simple bag, mask, non-rebreathing valve combination apparatus.

The bag, mask, non-rebreathing valve combination is considered to be a better unit for emergency resuscitation for the following reasons:

1. Simple to use.
2. Inexpensive.
3. Maintenance is negligible.
4. Readily adaptable to all types of artificial airways.
5. Does not require an oxygen source but may be adapted easily.
6. Nonmedical and paramedical personnel can be easily trained in its proficient use.

EVALUATION OF EVACUEES: PACOM HOSPITALS

The above comments concerning the care of severely traumatized patients in Vietnam apply to all patients who may arrive in PACOM hospitals for primary treatment from the field. However, the majority of patients being received at the present time from Vietnam have had at least one anesthetic prior to transfer. Except under periods of unusually heavy casualty flow, most of these patients will have been stablized and adequate pulmonary function established prior to evacuation. However, when these patients are transferred out-of-country in the immediate postoperative period fatigue develops and some dehydration and additional contraction of the blood volume is known to occur. Upon arrival in the PACOM hospitals, surgery and anesthesia should be delayed for at least a 24-hour period to permit rest and evaluation prior to induction of anesthesia for another surgical procedure. During this time the surgeon-anesthesiologist team can obtain the appropriate laboratory and x-ray studies and provide adequate hydration and blood replacement. There is the occasional patient who will require immediate surgery upon arrival at the PACOM hospital. He should receive the urgent emergency care and attention by the anesthesiologist expected under any other emergency situation.

SUMMARY:

The anesthetic management of the severely traumatized patient has been discussed in some detail. The greatest emphasis has been placed on the problems encountered in-country and during evacuation. Less emphasis has been placed on the problems faced in the PACOM hospitals because patients arriving there are relatively stablized. Emphasis has been placed on the importance of the surgeon-anesthesiologist team concept in the management of the severely traumatized patient.

DEBRIDEMENT

Debridement of combat wounds is the surgical technique of excising devitalized tissue. The experience in several wars has demonstrated that proper debridement is the key to surgical treatment of soft tissue wounds and provides the best means of reducing morbidity and mortality. In spite of widespread acceptance of this premise, with each conflict the surgical techniques must be relearned in the operating room through actual experience with the procedure. The eyes must learn to distinguish the difference between viable and non-viable muscle, and the fingers must develop a sensitivity for devitalized soft tissue. To become expert with debridement one must understand the pathology of the wound, inspect his results, and maintain a constant determination to improve his technic.

Briefly, the pathology of missile wounds is related to the type of missile, its velocity, the rotational axis, and the nature and extent of secondary missiles acting within the tissues.

SKIN - The elasticity of the skin allows for stretching as a high velocity missile passes through, therefore damage does not usually extend far beyond the traumatized edges.

FASCIA - Damage to the fascia is related more to loss of substance from a direct effect rather than destruction from lateral energy. The innocuous appearance of the fascia may disguise extensive cavitation beneath. The subfascial plane is a ready avenue for extension of infection after improper debridement.

MUSCLE - Of the soft tissues in extremities, skeletal muscle is the least able to withstand the shock wave and cavitation caused by dissemination of the lateral energy of a high velocity missile. Devitalized muscle can be recognized by its dark color, soft consistency, noncontractility and decreased bleeding of the cut surface.

ARTERY - Arterial injuries have a wide spectrum. They may be complete transections, open tears, small holes occluded with thrombus, contusions with intimal tears, contusions with aneurysm formation, and rarely, local spasm. The microscopic pathology of high velocity arterial wound extends several millimeters beyond that which is observed grossly. Acute A-V fistulae are frequent, especially in the femoral and popliteal areas and all areas of hematoma adjacent to vessels should be explored to rule out vascular injury.

TENDON AND NERVE - Tendon, nerve and fibers withstand lateral energy better than skeletal muscle and inspection will demonstrate the extent of devitalized tissue.

TECHNIQUE

The technic of debridement can be simple. However, for massive wounds when many anatomical structures are involved it may be a very challenging operation in which the surgeon must choose between leaving questionable

tissues versus causing morbidity by removing functioning tissue. A stepwise surgical plan, detailed knowledge of anatomy, careful technic, thoroughness, and good judgment are necessary for consistent success. The operation should progress in an orderly fashion with each tissue and plane being properly treated as it is encountered.

Like the cover on a book, the skin must be opened to discover what lies within. The incision should incorporate the wounds of entrance or exit. For extremities a longitudinal incision is preferred. Longitudinal incisions have the advantage of permitting any necessary extension for adequate exposure. When the joint creases are traversed, a curved incision to prevent contractures is indicated. Following the initial skin incision the skin wound is debrided. The ragged traumatized skin edges should be excised with a scalpel, taking a few millimeters of normal appearing skin. Excessive skin debridement is unnecessary and makes subsequent closure more difficult.

At NSA Hospital Da Nang, orthopedic surgeons have routinely used the electrosurgical knife on the skin during the last seven to eight months. The advantages are the decreased blood loss and operative time. Thus far there has been no indication of delayed healing or extensive cicatrix formation.

The fascia should be opened widely. As noted previously, it may appear almost normal and yet hide extensive underlying muscle destruction. Shredded loose fascia should be excised.

After opening the fascia, frequently a bulging hematoma is uncovered. This should be carefully evacuated by suction, irrigation and sponging. Copious irrigation at this time is very effective in flushing out clots, debris and foreign material. By sharp dissection the devitalized muscle is excised using for criteria of viability, the color, consistency, contractility and type of bleeding. Good hemostasis to prevent excessive blood loss and hematoma formation postoperatively is important. Mine explosions are prone to hurl massive quantities of soil into the wounds. Copious irrigation and surgical removal of this material is time consuming but essential to prevent infection.

Tendon does not usually require extensive debridement beyond the grossly destroyed fibers. Loose frayed edges and ends should be trimmed. Repair of tendons should not be performed at initial treatment of combat wounds. Tendons should be covered with soft tissue when feasible. However developing and rotating flaps for this purpose is not advisable. Drying of such exposed tendons is avoided by covering them with a strip of vaseline gauze before the dry dressing is applied.

Nerves do not require extensive debridement. Loose strands and all grossly destroyed tissue should be removed. To prevent additional displacement of transected nerves, the epineurium should be tacked to adjacent soft tissue utilizing any fine suture material available.

Digital nerves are the only ones in which a primary repair may be indicated.

A search should be made for vascular injuries. A good pulse preoperatively does not rule out vascular damage. Missed arterial injuries will almost invariably lead to some type of significant complication.

BONE - Small loose fragments of bone should be removed. Larger fragments should not be removed if this will result in shortening of an extremity. The piece should be debrided and cleansed if necessary and then returned to the natural anatomic location. Retained bone fragments associated with bladder or colon wounds frequently become sequestrated, perpetuating infection, therefore these should be removed at the initial surgery. When arterial injuries have associated unstable fractures, accessible spicules of bone near the repair should be trimmed to preclude subsequent trauma to the repair.

Upon completion of debridement the wound should be a healthy appearing cavity, with clean tissue edges and adequate exposure of all depths of the wound established. Following final inspection of the wound, the wound is dressed with sterile gauze without drains. For deep wounds, fluffs should be laid over the gauze, but the wound should not be packed.

Patients having extensive soft tissue wounds of extremities should have well-padded plaster posterior splints applied to decrease pain, rest the part, decrease drainage, and promote healing.

DEBRIDEMENT OF SPECIAL REGIONS

FACE - Due to the abundant blood supply of the face, less extensive debridement is needed. The wounds are closed with multiple fine sutures in the subcutaneous tissue and skin to produce a good cosmetic result. An attempt should be made to obtain skin closure without flaps; reserving their use for a more ideal time.

NECK - Explore all wounds to rule out vascular or esophageal injuries. Soft tissue of the neck may be closed primarily after debridement, when the esophagus is not injured.

CHEST WALL - When the intercostal muscles and pleura are involved, a check should be made for intercostal artery bleeding. Defects in the chest wall may require swinging a flap of muscle to obtain air-tight closure.

ABDOMEN - Individual wounds of the abdominal wall require debridement. If a laparotomy is performed a separate incision through normal tissues should be used.

HAND - Prior to the Vietnam conflict it was recommended that hand wounds should be closed after debridement. Experience in Vietnam has demonstrated that leaving hand wounds open following initial debridement is preferred.

FOOT - Foot wounds have been a problem due to inadequate debridement of the plantar tissues. The bulk of soft tissues in the foot are located on the plantar surface and adequate debridement through a hole on the dorsal surface is impossible. If a deep wound is present, a plantar incision is required. The majority of surgeons have a natural tendency to shy away from plantar incisions fearing a painful scar subsequently. There should be no hesitancy in making a plantar incision to debride the foot. Properly placed incisions between the metatarsal heads and avoiding the weight bearing areas are recommended.

Common Errors in Debridement:

A. Overlooking or missing a wound.

Areas in which this is likely are:

1) Perineum.

2) Rectum.

3) Back.

4) Scalp.

5) Axillae.

6) Beneath previously placed dressings.

B. Pin hole debridements.

C. Coring wounds and inserting drains.

D. Failure to debride through-and-through wounds of an extremity from both surfaces.

E. Removing excessive skin.

F. Gauze dressings packed to become a water and air-tight seal.

Redebridement is frequently necessary. This does not necessarily mean that the original debridement was inadequate. Between the initial and subsequent debridements there may have been delayed bleeding, extension of local infection and better demarcation of non-viable tissue.

Inadequate debridement may occur with

1) Inexperience.

2) Unrecognized wounds due to incomplete physical examination.

3) Inadequate exposure.

4) Tactical situation - the hospital may be under hostile fire.

5) Heavy casualty load.

6) Fatigue of surgeon.

Recommendations differing from those previously made:

1) Cover exposed tendons with vaseline gauze before applying the dry dressing.

2) For transected nerves, suture the epineurium to the adjacent soft tissue to prevent further displacement.

3) To preserve extremity length avoid removing segments of long bones.

VASCULAR INJURIES

It was generally agreed that a high index of suspicion must be maintained in the diagnosis of arterial injuries. There is no place for the statement that a questionable peripheral pulse is present. Unless a definite distal pulse is felt it should be considered absent and an arterial injury assumed until proven otherwise. In an extremity with multiple fragment wounds and a suspected arterial injury, the use of pre-operative arteriography is recommended to "pin-point" the location of the arterial lesion.

All members of the panel had seen instances of arterial injury with the presence of a peripheral pulse and a rather insignificant appearing fragment wound. This points out the need of adequate debridement in extremity wounds, laying the wound open widely enough so that the missile tract can be easily followed and its proximity to vessels determined without difficulty. In patients with suspected vascular trauma, of course, incisions of election should be used.

Careful and adequate debridement of all devitalized tissue is of utmost importance in the wound associated with an arterial repair. If the repair is covered by non-viable tissue, subsequent infection and "blow-out" of the arterial repair is assured. In some instances it will be necessary to swing local muscle flaps following debridement to provide coverage of the arterial repair. When this is not possible extra-anatomic venous bypass grafts can be utilized, tunneling away from the debrided wound and ligating the injured vessel well up under the edge of the debrided wound so that it will retract into normal tissue. In the rare instance of massive soft tissue loss in the groin, an obturator foramen venous bypass graft should be considered.

The majority of arterial injuries in Vietnam are repaired with reversed saphenous vein grafts, as the artery must be debrided at least one centimeter beyond grossly visible injury, making an end-to-end anastomosis untenable in most instances. A preliminary report from Dr. Manion at the Armed Forces Institute of Pathology demonstrated microscopic trauma extending to the edge of the resected specimen in 26 arterial lesions from Vietnam.

The saphenous vein graft should be obtained from the opposite leg, to minimize interference with venous drainage in the injured extremity. Hydrostatic dilatation of the saphenous vein prior to anastomosis is considered mandatory to ensure proper functioning of the vein graft. There should be no hesitation in re-exploring an arterial repair if distal pulses do not appear within six hours after repair, and in some cases multiple re-operation is necessary to salvage the extremity.

In wounds with associated venous injuries, venous repair should be performed where possible. This usually entails lateral suture repair or occasionally an end-to-end anastomosis. Venous replacement grafting

(using the contralateral saphenous vein) should be reserved for the extremity with total interruption of venous flow.

Arterial injuries associated with unstable fractures, especially the femur and humerus, do not pose a significant problem if properly treated. In general, venous replacement grafts should be used to preclude any tension on the anastomotic suture line. Soft tissue should be closed between the fracture and arterial repair to avoid impingement on the graft. Adequate stabilization is afforded by a circular cast, and these casts should be monovalved rather than bivalved. If indicated, skeletal traction can be cautiously instituted 10 to 14 days after arterial repair. Only in rare circumstances is intramedullary fixation justified to prevent damage to the arterial repair.

The use of routine fasciotomy is decried in arterial injuries of the lower extremity. There should be no hesitation, however, in (1) the severely ischemic limb with beginning edema, (2) when an undue length of time has elapsed between injury and repair, (3) when total venous interruption is present, (4) when significant distal soft tissue contusion is present, or (5) when evidence of compartment compression appears postoperatively. It is recommended that both the anterior and peroneal compartments be decompressed through the anterior fasciotomy incision. In addition, both the superficial and deep muscle groups of the posterior compartment should be decompressed through the posteromedial fasciotomy incision. This amount of decompression is felt to be essential and cannot be accomplished through a "pin hole" skin incision.

Subsequent necrosis of muscle compartments in the leg is not unusual in popliteal artery repairs, especially when the distal popliteal artery is involved. This can occur even in the face of a successful repair, may not appear until 4-5 days postoperatively and is probably due to the ischemia sustained prior to vascular repair. It is not unusual for the superficial muscle to appear viable at the time of inspection of the fasciotomy site. Only after dissection of the muscle groups is the true extent of necrosis realized. Frequently the entire anterior and peroneal compartments must be debrided, and the deep muscle group of the posterior compartment is also prone to ischemic necrosis.

Because of the significant incidence of late anastomotic disruptions and hemorrhage, it is strongly recommended that all arterial repairs not be transferred by air for a minimum of 21 days following the repair. This minimizes the incidence of hemorrhage occurring during flight, which has occurred not infrequently with premature evacuation.

It cannot be emphasized too strongly that when anastomotic leakage occurs, repair of the leaking site with simple suture is doomed to failure, with recurrent hemorrhage in one to two days. The arterial repair must be reconstructed. If infection is the etiology of the anastomotic disruption, adequate debridement must be performed and the principles of extra-anatomic bypass grafting should be utilized.

The use of prosthetic materials such as dacron or teflon is only rarely justified in contaminated war wounds. The only exceptions to this statement are:

(1) Great vessel injuries, such as thoracic or abdominal aorta. Saphenous vein grafts work well in external iliac artery replacement.

(2) When no vein is present for use as a replacement graft. This problem arises most frequently when multiple procedures are necessary in an attempt to salvage an arterial repair. In these instances the principles of extra-anatomic bypass grafting should be utilized, with proximal and distal anastomoses to normal, clean vessels and the graft being routed away from the infected wound.

TABLE #1

Table #1 shows 267 arterial repairs performed in Vietnam from July through December 1967. There were 78 of the brachial artery, 84 of the femoral artery and 45 of the popliteal artery. Lateral suture repair was used in only 10 cases. End to end repair was performed in 100 (37.4%) and a new graft was used in 157 (58.8%). The amputation rate was 13.5% in this group.

ARTERIAL REPAIRS

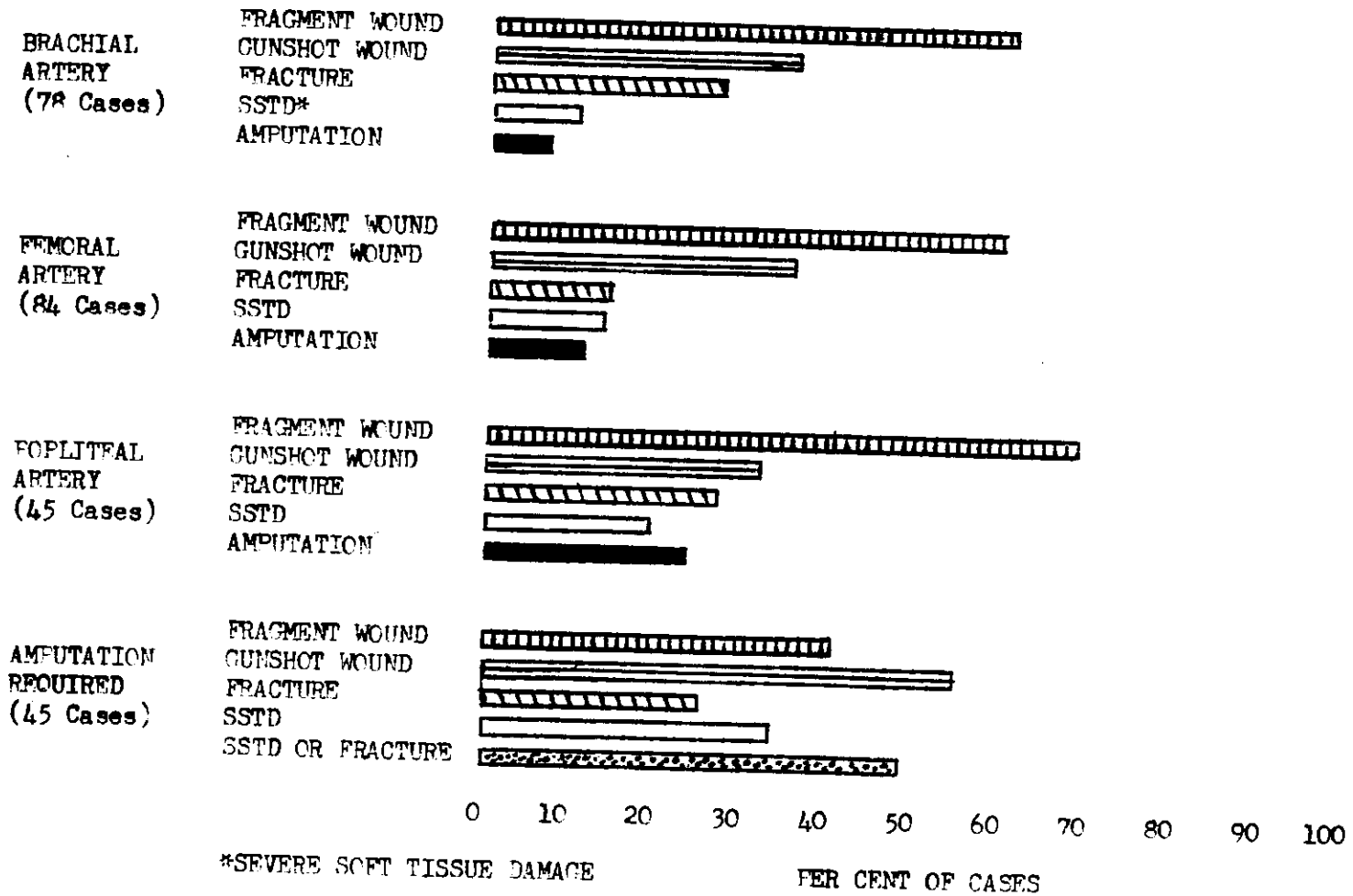
(267 Cases)

	TYPE OF REPAIR							DAYS OF FOLLOW-UP		
	WOUNDING AGENT					AMPUTATION				
ARTERY	FRAG%	GSW%	LAT SUT	END TO END	VEIN GRAFT	CASES	%	USARV	PACOM	TOTAL
Brachial	63.0	37.0	2	28	48	7	8.9	13.7	12.3	26.0
Femoral	61.5	38.4	4	39	41	10	11.9	16.2	20.3	36.5
Popliteal	69.4	30.5		13	32	11	24.4	14.3	14.3	28.6
Axillary	70.0	30.0		6	7	0				
Iliac				4	6	0				
Tibial				4	3	0				
Subclavian				1	5					
Ulnar			1	3		1				
Carotid	93.4	6.6	2	2	15					
Innominate			1							
Total			10	100	157	29				

TABLE #2

This shows the association between the severity of the wound and the amputation rate. A gunshot was the wounding agent in more than half of cases requiring amputation. There was either a fracture or severe soft tissue damage in about 50% of cases requiring amputation. NOTE: 29 of the cases requiring amputation are from the group reported in table #1, the other 16 are from another group of patients.

ARTERIAL REPAIRS
ASSOCIATION OF PATHOLOGY WITH AMPUTATION RATE
207 CASES



*SEVERE SOFT TISSUE DAMAGE

NEUROSURGERY

Cranio Cerebral Trauma

A. Penetrating Wounds Management and Recommendations:

1. X-rays: Pre-op films in at least two planes. Post-op x-rays in at least two planes as soon as possible after surgery. Stereo-lateral x-rays are also of considerable value when available.

2. Adequate debridement of skin, skull, dura and brain.

3. Removal of all intra-cerebral bone fragments.

4. Removal of accessible metallic fragments and all intraventricular metallic fragments.

5. Always achieve primary closure of dura or dural closure with pericranium, temporalis fascia or fascia lata from the patient.

6. Always achieve primary scalp closure utilizing scalp flaps and split thickness skin grafts at donor site if necessary.

7. Immediate reoperation if retained bone fragments are seen on post-op films.

8. Mannitol or urea should not be generally used as an adjunct during surgery to achieve brain relaxation except for the repair of dural lacerations on the undersurface of the brain.

9. Anticonvulsant medication postoperatively in all cases. Phenobarbital and/or Dilantin are generally used.

10. Prophylactic antibiotics in all cases. Penicillin and Chloromycetin intravenously and orally are commonly used.

11. All CSF fistulas thru operative wound should be closed prior to further evacuation.

12. Exenteration of frontal sinus whenever it is involved.

B. Tangential Wounds Management and Recommendations:

1. Craniectomy in all cases plus exploration of underlying brain and removal of hematoma and necrotic brain.

2. Primary dura and scalp closure.

3. Anticonvulsants in all cases.

C. Other Recommendations:

1. It is suggested that each neurosurgeon newly assigned to Vietnam should spend his first two weeks at a PACOM hospital to become familiar with the early complications of cranio-cerebral trauma occurring in current combat casualties.

2. Careful complete debridement of devitalized brain is essential.

3. Drains should be avoided except in unusual circumstances.

4. Bank dura or freeze dried dura should not be used until further studies can be made on its infection potential in war wounds.

5. It is suggested that radio-opaque cottonoids and/or cotton paddies with strings be used in the debridement of cranio-cerebral trauma.

6. Steroids such as Decadron and Solu-Medrol can and should be used in selected cases; however, these are not recommended as a routine measure. When used, withdrawal after 3-5 days has not been associated with any problem.

7. Investigation toward a lighter, more wearable helmet should be carried out.

8. Use of Teflon substitutes in venous sinus repairs has been associated with significant infection and should be used with discretion only when all else fails.

9. Modification of the present head injury form should be considered both in form and content. Assistance in this record keeping is necessary because of the detail required.

10. Gross brain infection should be treated with aggressive debridement. The open method should be employed when faced with extensive cerebritis and cerebral fungus.

11. Postoperative spinal taps are considered to be of value both diagnostically and therapeutically.

12. Arteriography is occasionally of value in the postoperative period but seldom preoperatively.

13. Gram negative infections, particularly Pseudomonas, Klebsiella and Proteus, are far more prevalent in cranio-cerebral injuries.

14. Frontal injuries with frontal sinus and orbit involvement require careful attention to water-tight dural closure. The involved air sinus should be obliterated by closure of the ostia with a firm muscle pack after the damaged mucosa is stripped.

15. The use of foreign substances such as gelfoam and bone wax should be kept to a minimum.

16. Craniotomy should be considered when the cerebral exposure required is large and the area of bone defect is small. Craniectomy of the involved bone should nevertheless be carried out in all cases of bony penetration.

Spinal Cord Trauma

Among those recommendations agreed upon by the group were the following, thought to be generally incontrovertible, fully consistent with well established principles, and supported by analysis of the recent experiences of the group members.

A. Treatment of compound injuries (usually by missile) of the spinal axis and its contents.

1. Early, adequate debridement of the wound following well proven general surgical principles, with special attention to careful, complete laminectomy and removal of devitalized bone fragments.

2. Complete decompression of the spinal cord or cauda equina, removing compressing bone or metal fragments.

3. Dural closure when possible.

4. Isolation of the spinal wound from another, if possible, by complete closure of the laminectomy wound unless it must include the missile tract.

5. Aggressive paraplegic or quadriplegic care with attention to pulmonary, intestinal, and urinary tract function and prevention of infections. Use of Stryker or Foster frames is recommended. Use of assisted respiration (I.P.P.B.) often is useful.

B. Closed injuries with neurologic deficit caused by missiles involving the abdominal or chest cavities or neck without x-ray evidence of spine involvement.

1. Generally neurosurgical investigation is recommended when the patient's condition permits. This may include spinal tap and myelography. Surgical intervention is undertaken at the judgment of the neurosurgeon depending upon his analysis of the pathology involved in the neurological deficit.

C. Closed injuries from blunt trauma.

1. The general principle of early neurosurgical evaluation and treatment is again emphasized. However, the group could not be dogmatic about surgical intervention in all cases; the individual surgeon's judgment being most important in the specific situation.

2. The use of steroids and/or mannitol is generally recommended.

3. Progressive neurologic deficits demand rapid neurosurgical attention.

The neurosurgical study group feels that the statistics on the mortality and morbidity of certain combined wounds are alarming and require joint study and recommendations. Specifically, those compound wounds involving the spinal cord and the retroperitoneal area, usually with involvement of the kidney or colon, subsequently developing infections, have resulted in a higher mortality rate. We recommend only adequate drainage in these cases, but feel that more adequate original debridement, better drainage of the retroperitoneal area, and earlier attention to the febrile patient would result in improved mortality and morbidity statistics. Delayed evidence of spinal osteomyelitis has been noted. Of interest is the relatively low incidence of meningitis, and the ability of the subarachnoid space to seal itself early in missile wounds. Those with meningitis almost invariably have continued contamination by an abscess in communication with the spinal canal.

Most of the battle casualty patients have had injuries involving multiple systems and have required a team approach. In these patients most often the neurosurgical aspect of the case is not the one of most immediate concern. Nevertheless, the neurosurgeon should be involved in the early care of the patient, and delayed laminectomy is to be considered in the same light as delayed debridement. It is well known that early decompression of neural tissue gives the best hope for functional recovery.

Other significant factors in the management of spinal cord injury cases are:

1. Suprapubic cystostomy is to be avoided unless it is absolutely mandatory.

2. Indwelling Foley catheter should be used during initial care and treatment. Complete agreement on the frequency of catheter change and irrigation and type of irrigation agent was not arrived at. Antibiotics such as Mandelamine, sulfas or furadantin should be employed to minimize urinary tract infections. The catheter should be attached to a closed system.

3. Intermittent catheterization BID or TID is not desirable or practical in the present circumstances.

4. The catheter should be taped to the abdomen to avoid penoscrotal fistulae.

5. Stabilization of the spine is seldom necessary in these injuries.

THORACIC SURGERY

GENERAL CONSIDERATIONS:

Management of a patient with a thoracic injury has been very satisfying and the overall results have been excellent. Few patients who survive to reach a definitive treatment facility have died as a result of a thoracic wound. The major problems in managing chest injury patients continued to be (1) wet lung and (2) management of severely wounded patients with multiple injuries in whom the chest injury represents only one of many wounds.

Conservative management is the rule. Only 5 to 10 percent of patients require formal thoracotomy. The vast majority of patients can be managed conservatively and vigorous conservative management is necessary whether or not the patient comes to later surgery.

There are some differences in overall management that have come into focus in Vietnam. These are:

(1) Earlier and more frequent use of chest tubes and less frequent use of thoracentesis.

(2) More frequent use of positive pressure ventilatory assistance.

(3) Use of blood gas determinations as a guide to oxygenation.

The overall goals in the management of the chest injury patient are:

(1) Obtain a clear pleural cavity,

(2) Obtain a clear tracheobronchial tree, and

(3) Restore blood volume losses.

INITIAL CARE:

The principles of early emergency care for thoracic injuries were reviewed by the group and were considered sound. These consist of the use of occlusive dressings on all chest wounds, splinting of the unstable chest wall with bulky dressings, proper positioning of the patient with the injured side down or transportation in a semi-sitting position if feasible, venting of the pleural cavity with a chest tube when indicated, early encouragement of the patient to breathe deeply and cough, and initiation of fluid therapy. It was agreed by the group that chest tubes can and should be placed in the pleural cavity at forward medical locations. It was felt that a properly placed venting chest tube did not offer a significant hazard to the patient. It was recognized that misplaced and ill applied chest tubes could be harmful to the patient. However, it was

considered to be an acceptable risk in view of the benefits of early placement of a chest tube. The Heimlich valve should be utilized during all periods of transportation and not underwater seal drainage. The chest tube should be single and of large bore size. It should be placed in the low anterolateral chest on the site of injury. It should not be placed through the wound. The experience with the Heimlich valve has shown that the valve is of benefit in venting pneumothorax but is less beneficial in draining a hemothorax. However, Heimlich valves must be placed properly. Instances were reported when valves were inserted backwards, the tube was clamped proximal to the valve, valves were broken, and the surrounding plastic bag was not vented.

INITIAL HOSPITAL MANAGEMENT:

The principles of early resuscitation within the hospital were reviewed and were considered entirely sound. Attention to the airway including early use of tracheotomy for airway resuscitation was considered most important. Fluid and blood replacement, relief of pain and proper positioning of the patient are all considered important. Most patients with significant thoracic injuries should have a central venous pressure catheter in place. If a venting pleural cavity tube has not been placed prior to hospitalization then a single large bore chest tube should be placed in the lateral chest wall in the axillary line for immediate venting. According to the wound location and the obvious presence of hemo- or pneumothorax on physical examination, the chest tube can be placed prior to x-ray examination. In patients whose clinical condition permitted and who did not appear to be deteriorating significantly or in whom aeration appeared to be satisfactory, x-ray evaluation prior to placement of the chest tube was indicated. The group felt that if the patient was to be subjected to the trauma of transportation to the x-ray facility, then lateral views should be obtained in addition to the standard posteroanterior view and if at all feasible upright films of the chest should be made.

It was considered most important that with the use of a single chest tube immediate suction drainage should be employed in addition to underwater seal. This offered more rapid evacuation of air and blood from the pleural cavity and early reexpansion. If a single chest tube did not clear the pleural cavity, then upper and lower chest tubes should be used without hesitation.

Vigorous resuscitation must be employed to prevent pulmonary complications and wet lung. Relief of pain is essential to permit the patient to cough and clear the tracheobronchial tree voluntarily. Measures to relieve pain consisted of use of narcotics judiciously and intercostal nerve block. In most experience, intercostal nerve block was used relatively infrequently.

The following treatment methods are in general use:

(1) Conservative management of the intrapleural damage with debridement and closure of the chest wall in accordance with priorities established for any wound.

(2) Use of the wound opening for intrapleural exploration during the time of wound debridement. This method is used frequently. Removal of blood and blood clots, control of hemorrhage, repair of minor lacerations of the lungs and removal of accessible foreign bodies can all be successfully employed utilizing the thoracic wound. The chest wall wound can be extended to provide a limited thoracotomy opening for better exposure when indicated. In general, extension of the wound should be employed when the chest wall wound is properly located, not severely contaminated and problems in wound closure will not result.

(3) Use of a formal thoracotomy incision separate from the wound. This is usually performed upon specific indication.

INDICATIONS FOR THORACOTOMY:

The recognized indications for thoracotomy were reviewed and are considered the same as in all past experience. These are:

(1) Bleeding.

(2) Airleak.

(3) Mediastinal injury.

(4) The chest wall wound itself.

(5) Use of thoracotomy for closure of the right diaphragm when not possible at laparotomy.

Continued or massive intra-thoracic bleeding has been the major indication for thoracotomy in nearly all experience. The next most frequent indication for thoracotomy was large defects of the chest wall which required surgical attention. Airleak and mediastinal injuries have been relatively uncommon causes for thoracotomy, but additional cases where heart or great vessel repair is done, are being collected.

Since the large wound of the chest wall requires no difficulty in recognizing the need for at least a limited thoracotomy, the major problem in determining the need for early thoracotomy is continued intra-thoracic bleeding. Continuous observation is essential. The amount of bleeding cannot be specified; surgical judgment must be employed to determine if there is a continuing blood loss of significant amount after initial successful resuscitation. Obviously if the patient reaches a medical facility with massive continuing blood loss, no time should be spent before the chest is opened. Sixty-seven of 629 patients reported at the previous conference had initial thoracotomy. The indications were hemorrhage, 24 (35.8%); associated intra-abdominal injuries, 13 (19.4%); defects of the chest wall, 11 (16.4%); a cardiac wound, 4 (5.9%). The remaining thoracotomies were performed for miscellaneous or unspecified reasons.

Massive airleak in patients has not been a significant problem. Tracheal or bronchial rupture occurs more frequently in those patients

who sustained fatal wounds. Patients with massive airleak as the major presenting problem should be managed conservatively initially to ascertain the size and nature of the airleak itself. With suction temporarily discontinued, the patient who can develop negative intrapleural pressure on inspiration probably does not have a major bronchial injury and, in general, will not require surgical correction of the leaking area.

SURGICAL MANAGEMENT:

Small wounds of entrance and exit are debrided, frequently under local anesthesia. If severe contamination or significant devitalized muscle is not present, these can be successfully closed primarily. If doubt exists the skin and subcutaneous tissue should be left open for delayed primary closure. Larger wounds of the chest wall require general anesthesia and endotracheal intubation for surgical management. The skin and subcutaneous tissue should be left open for delayed primary closure. If the pleural cavity is open, then inspection and any necessary corrective measure should be employed. Generally this is limited to careful inspection of the chest wall to insure that hemorrhage is controlled, repair of minor lacerations of the lung, clearing of the pleural cavity of blood and blood clots, and removal of partially detached lung. Usually the originally placed chest tube is replaced with anterior and posterior chest tubes for optimum drainage.

In still larger wounds of the chest wall, defects can and should be closed by use of normal tissue which include shifting of muscle flaps when required. The use of foreign materials for closure of the pleural cavity is not recommended. Sometimes mere closure of the skin and subcutaneous tissue over a defect with reinforcement by a bulky dressing is successful. Rib fragments should be removed and injured rib ends should be freshened to prevent subsequent lung damage.

A separate formal thoracotomy is more commonly used to control bleeding or to perform pulmonary resection. Resection of lung (usually lobectomy) is done for two chief reasons: hilar damage to bronchus or artery and massive lobar destruction. Resection should be avoided even if widespread contusion or through and through missile holes are present. Resection is generally preferred to repair of major bronchial injury, especially if tailoring or complicated repair is required due to loss of membrane or cartilage fractures.

INJURIES TO THE HEART AND GREAT VESSELS

Rarely does a patient with a major cardiac or great vessel wound survive to reach a medical facility in spite of rapid helicopter evacuation. The material from the previous report was reviewed as follows:

There were 12 patients with cardiac injuries. Three required suturing only; 3 were treated by pericardiocentesis alone; pericardiocentesis and delayed pericardiotomy was employed in two patients; two patients required no treatment and one patient had delayed thoracotomy for decortication and at that time pericardiotomy for evacuation of a hematoma was done. Since this

report, 13 additional patients with wounds of the heart or great vessels were reported. These consisted of 4 wounds of the right ventricle, 4 wounds of the right atrium, 3 wounds of the left ventricle, 1 wound of the superior vena cava and the innominate artery and 1 wound of the pulmonary artery. Of these 13 patients, 2 died. One resulted from a severe wound of the innominate artery and superior vena cava and the other resulted from a grazing wound of the left ventricle in which there was associated severe pulmonary injury. The cause of death was blood loss in both instances. Patients with evidence of small penetrating wounds to the heart with normal vital signs should be observed carefully, chest x-rays should be taken serially, EKG determinations should be made and careful monitoring of the central venous pressure should be done in order to determine if cardiac tamponade might result.

PERICARDIAL TAMPONADE

Cardiac tamponade should be suspected in all patients who do not respond to the usual resuscitative measures for thoracic injury patients and should be especially suspected in those patients who demonstrate a missile fragment on x-rays in the location of the heart or great vessels. Persistent rapid pulse and respiration were considered reasons for suspicion of tamponade. Distention of the neck veins, elevation of the central venous pressure, decreased systolic pressure, narrowed pulse pressure, and quiet heart sounds were all considered significant findings. An enlarged cardiac silhouette on x-ray is not necessary for a diagnosis. Paradoxical pulse or blood pressure are relatively late findings.

The overall condition of the patient is the major determinant in the type of treatment that should be employed. All observers recommended needle aspiration via the xiphoid route and if this was unsuccessful in relieving symptoms, then immediate thoracotomy was indicated. If the initial needle aspiration was successful and later the patient develops signs of cardiac tamponade, then exploration is indicated. Standard anterolateral thoracotomy incisions were generally recommended.

The indications for removal of foreign bodies of the heart were reviewed. In the absence of evidence of cardiac tamponade, it was felt that the patient should not be explored initially for removal of such foreign bodies. The policy established at the previous conference of not attempting to remove metallic fragments unless there is hemorrhage, infection, tamponade or recurrent pericardial effusion was confirmed. Late removal of metallic foreign bodies in the region of the heart in the asymptomatic patient was considered a matter of overall evaluation of the patient and surgical judgment. All such patients should be treated at facilities having cardiopulmonary bypass available.

WOUNDS OF THE ESOPHAGUS

No intrathoracic injuries of the esophagus were reported. The reason that such wounds are so rare in all past battle field experience probably is because such wounds are associated with major lethal injuries to the heart or great vessels.

THORACOABDOMINAL INJURIES

The thoracic injury should be managed conservatively and abdominal exploration performed as the method of choice in the vast majority of patients. Thoracoabdominal incisions are rarely employed and then only in unusual circumstances. If both laparotomy and thoracotomy are required, separate incisions are employed. The site of initial exploration is determined by the clinical condition of the patient. In all penetrations of both the abdominal and thoracic cavities, the diaphragm should be repaired. In most instances this can be accomplished during the time of laparotomy. Occasionally, a separate small thoracotomy incision is required for repair of the right diaphragm when not possible from below. Massive injuries to the colon, liver and lung carried a very high mortality. It was reported that complications resulting from large thoracoabdominal injuries occurred in almost 60% of patients. In 91 thoracoabdominal wounds reported by the Army, postoperative bleeding below the diaphragm resulted in five cases, infections in the peritoneal cavity were present in 34 cases and 14 patients developed pulmonary complications of significant degree. It was stressed in all instances that total management of the abdominal injury cannot be accomplished through the thoracotomy incision. If thoracotomy is required in patients with intraperitoneal injury, then subsequent laparotomy will be necessary for complete exploration.

WET LUNG

This condition encompasses a wide variety of pulmonary complications occurring in both thoracic injury patients and in patients with injuries elsewhere. Essentially the established case manifests ever decreasing pulmonary ventilation and oxygenation, decreasing lung compliance and a high mortality despite all known measures. Apparently, one essential pathophysiological change is failure of oxygen transport at the pulmonary-capillary level due to blockage and flooding of alveoli. Numerous clinical factors are recognized. Among these are bronchial obstruction, flooding from increased capillary permeability due to local hypoxia, pulmonary edema from fluid overload or other causes, aspiration of blood and other foreign material, parenchymal destruction from high velocity damage, sludging of red cells from changes in protein coating associated with metabolic acidosis and other factors, microvascular thrombosis, A-V shunting within the lung, and damage due to high concentration of oxygen administered under positive pressure. Thus, any number and variety of injuries and insults may set the cycle in motion. Failure of tracheobronchial toilet, missile destruction, overtransfusion, local hypoxia and poor pulmonary circulation from shock, embolization and even respirator treatment can be incriminated.

Several clinical varieties of wet lung are described. One is a milder variety usually found in patients with little or no lung damage and in whom tracheobronchial obstruction and atelectasis from aspiration and retained secretions are the major findings. Treatment is usually successful. There is some question as to whether or not this represents true wet lung or whether this is a preliminary stage leading eventually to vascular complications and flooding of the alveoli if not treated properly. Another type

is that occurring in patients without initial lung damage but in association with embolization to the lungs, sepsis, CNS damage and other causes. Apparently fully developed cases undergo the same progressive pulmonary deficiency as do patients with lung damage. A third type is the one associated with severe high velocity or blast injury to the lungs which may develop acutely.

Wet lung is described as developing slowly over several days in patients undergoing conservative treatment, developing immediately after operation, and being present in full degree on admission to the hospital of patients with severe lung damage. Most cases develop during the initial 2 to 6 days post-injury. Analysis of the lungs in these patients after death has revealed a variety of findings with the major and more frequent findings being a heavy, wet, edematous, hemorrhagic lung in which on microscopic examination there is flooding of the alveoli with pulmonary edema fluid or blood, small vessel thrombosis, foci of a bronchial pneumonia and even hyaline membrane formation in some instances. Analysis of some of these lungs indicated that there is loss of surfactant. Evidence of both right and left heart failure has been found. Some of these changes are given in the report from NSA Station Hospital which follows.

Case I (A-011-68 DN): 19 year old white male who was admitted after sustaining multiple shrapnel wounds to the head, extremities, and abdomen. The tibiae were fractured as was the right distal ulna. The blood gases postoperatively were within normal limits with a pO_2 195 mm (resp.), O_2 Sat. 99.6%. The urine fats were positive. Soon thereafter the patient was noted to become cyanotic when taken off O_2 and the pO_2 was 63, with pCO_2 14, HCO_3 13. The chest was clear to auscultation. The patient became increasingly difficult to ventilate and expired five days after wounding. At autopsy, the lungs partially filled the pleural cavities with 500 cc's of blood tinged yellow fluid on the right and 150 cc on the left. Fibrinous adhesions were present on the right. The lungs weighed 1700 gms. with multiple petechiae scattered over the pleural surfaces. The lungs were firm and contained yellowish nodular areas which microscopically were foci of bronchopneumonia. In areas not involved with the bronchopneumonia, there was extravasation of red cells and edema fluid into the alveolar spaces, plus pneumocytic macrophages. Hyaline membranes were not prominent.

Case II (A-017-68 DN): 21 year old white male who received a through and through missile wound of the neck and multiple shrapnel wounds of the legs. He was hypotensive on admission. The blood gases on admission were normal except for a low pCO_2 and pH 7.54. It became increasingly difficult to ventilate the patient over the next 72 hours with diminishing pO_2's and he expired. Each hemithorax contained 500 cc of straw colored fluid and there was an extensive subpleural hematoma in the apex of the left pleural cavity. The lungs weighed 1650 gms., were firm and all lobes were purple and hypocrepitant. There was a copious ooze of fluid from the cut surfaces except the left lower lobe which was atelectatic. Microscopically, the histological picture was that of pulmonary hemorrhage and edema. The heart was normal.

Case III (A-027-68 DN): 19 year old white male was admitted in severe hemorrhagic shock secondary to wounds of the face, right arm and leg, and abdomen. The right radius and ulna were fractured plus an open comminuted fracture of the femur. Postoperatively, he developed noisy respirations. The blood gases were pH 7.355, with low pO_2 and slightly $\uparrow pCO_2$. Rhonchi developed with a febrile course ensuing. The pO_2 was 57 on nasotracheal O_2. The chest film revealed bilateral infiltrates. The patient died four days after admission with progressive alveolar capillary block.

Case IV (A-026-68 DN): 20-year-old white male was admitted after receiving multiple shrapnel wounds to the extremities with a left femoral artery injury. Because of the progressive deterioration of the lower extremity wounds, it became necessary to perform bilateral below the knee amputations. The chest was clear four days after wounding however by the eighth day wheezes developed and signs of congestive heart failure ensued. The X-ray revealed bilateral pulmonary infiltrates. The patient was toxic and febrile. The urine was fat positive. Blood gases during the period revealed metabolic acidosis and hypoxia with pO_2 36, O_2 Sat. 59%. The patient was refractory to ventilatory efforts. Bloody frothy sputum was noted and he expired nine days after wounding. The right hemithorax contained 150 cc of straw colored fluid while the left was normal. The lungs weighed 2000 gms. and were firm and hypocrepitant. Multiple scattered hemorrhages were noted over the pleural surfaces. There was a copious ooze of bloody fluid from the cut surface and microscopically there was a diffuse extravasation of blood into alveolar spaces, with fluid and hyaline membrane formation. The right ventricle was not dilated.

Case V (A-031-68 DN): 18 year old white male was admitted in shock with multiple shrapnel wounds of all extremities, with multiple fractures and intra-abdominal trauma; a fragment was present in right chest. The blood gases on admission were reasonably normal. Postoperatively, diffuse oozing through the bandages and progressive cyanosis with diminishing pO_2's occurred. Rales increased and ventilatory efforts became more difficult with an inability to raise the O_2 saturation above 70%. Forty-eight hours after admission, he expired. At autopsy, the left hemithorax contained 800 cc of dark yellow fluid and there was 250 cc of clotted blood on the right. The lungs weighed 2750 gms. All lobes were firm, hypocrepitant and there were multiple contusions of the right lung especially the right lower lobe. On cut section, there was a copious ooze of bloody fluid and microscopically the same picture as noted in Case IV.

Case VI (A-033-68 DN): 20 year old white male stepped on a land mine and was admitted in severe shock and traumatic amputations of both lower extremities. The blood gases revealed severe acidosis and hypoxia. He died approximately 24 hours after admission. The lungs were congested and edematous, weighing 1650 gms. There were multiple bone marrow and fibrin thrombi. The left lower lobe was contused.

DISCUSSION

These cases are representative of a much larger group of cases and a syndrome both clinical and anatomical has emerged. Most of the patients have sustained multiple shrapnel wounds which have noticeably involved the extremities (note case I through VI). As a group, severe hypovolemic shock was present on admission and resuscitative efforts were more or less successful to the point that the patients could be operated upon. The blood gases on admission revealed a respiratory alkalosis (Shock Study Results, L. CAREY, LCDR, MC, USN et al) which is the result of hyperventilation. Some of the patients are started on low flows of O_2 in the triage area thru nasal catheters. Postoperatively, the patients do reasonably well for varying periods from 24 hours to 5 or 6 days. One of the earliest clinical signs of impending difficulty is tachypnea and minimal cyanosis followed by tachycardia. The auscultation of the chest reveals mild basilar rales. The blood gases reveal a fall in the pO_2 to less than 100 mm., a lowered pCO_2 and an O_2 saturation of less than 90%. When these changes become manifest the clinical picture deteriorates rapidly with almost total dependence on the respirator and increased resistance to ventilation by the respirator. It becomes increasingly difficult to maintain the pO_2 and O_2 saturation regardless of O_2 flows. The central venous pressure is more often than not within the normal range and the blood pressure and urine output steadily fall. A copious ooze of bloody, frothy material makes the clearance of the tracheobronchial tree more difficult.

Anatomically, pleural effusions are present at autopsy with lungs which are markedly increased in weight, ranging from 1600 to over 3000 gms. (normal 800-1000 gms.). The lungs are very firm and rigid on palpation. When blunt or direct trauma is transmitted to the chest, there are often contused lobes which differ in that the lobe is more consolidated and hemorrhagic. The visceral pleural surfaces are smooth, glistening, and purplish-blue in color. A nodular sensation on palpation often reveals the presence of bronchopneumonia microscopically. This is not an uncommon associated finding. The leaves of the diaphragm are often depressed because of the hypervoluminous character of the lungs. The lungs are generally hypocrepitant. When the lungs are sectioned, the cut surfaces are very even because of the firmness. From the cut surface, there is a generalized ooze of bloody, bubbly fluid. The tracheobronchial tree is hyperemic and is filled with bloody, tenacious fluid. The pulmonary artery is unremarkable grossly in most cases.

The weight of the heart is within normal limits between 350-400 gms. There is, however, evidence of acute right ventricular dilation with an increased circumference of the tricuspid valve (greater than 120 mm). This finding is interesting in the light of normal central venous pressure in most cases.

Microscopically, the lungs have multiple features. The alveolar septi are not thickened but the alveolar capillaries are prominent as a result of congestion. The alveolar spaces contain either singly or

in combination extravasated red cells with homogenous eosinophilic material consistent with edema formation. Often intermixed with the edema fluid are many pigment laden pneumocytic macrophages. In the more consolidated areas (not as a result of contusion), there are well formed hyaline membranes applied to the alveolar wall. An admixture of the other elements is also noted. These hyaline membranes cannot be differentiated from those seen in hyaline membrane disease of the newborn, uremic pneumonitis, or adenovirus infections. In only a few cases have thromboemboli been demonstrated and fat embolization has been noted in 25% of cases so far. Scattered foci of bronchopneumonia have also been noted. (End of Report).

The impressions from the previous conference on the common factors in the clinical syndrome of wet lung were reviewed. The following findings were generally present in those patients who developed the more malignant variety of wet lung.

1. Ten or more units of blood had been transfused.

2. Most of the patients had been in a state of severe shock for an unknown period of time.

3. Most had good renal output with adequate specific gravity.

4. The arterial PH was unknown and the patient generally had received sodium bicarbonate.

5. Initially, a normal chest x-ray was present.

6. The central venous pressure was monitored and found frequently to be normal or below normal.

In the previous conference overtransfusion as a possible cause of wet lung was considered highly significant. As additional observations have been made since the last conference, the possibility of wet lung developing from overtransfusion is considered greater when significant parenchymal pulmonary damage and pulmonary contusions are present and when aspiration of blood from the injured lung into the normal lung has occurred. In this type of patient, careful monitoring to avoid fluid overload as resuscitation progresses is exceedingly important. Other patients with chest wall trauma, but essentially normal lungs, are perhaps not as susceptible to fluid overload. There was not full agreement on these points by the conference attendees. As discussed in the proceedings from the previous year, the possible role of noxious reflexes, allergic phenomena, and a humoral mechanism were considered. It was the general consensus that [illegible] detailed clinical observation of many cases and careful recording of all medical findings for analysis, followed by appropriate research, would be necessary before any or all of these etiological factors could be accepted or discarded.

TREATMENT:

The usual measures employed in treatment were reviewed. The most important were tracheobronchial toilet, restoration of a normal blood