

MOBILE NEUROSURGICAL TEAM*

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IN THE TREATMENT of casualties with missile wounds of brain and spinal cord, the Army Medical Corps' ultimate twofold goal is maximum restoration of function, and rehabilitation. The achievement of this goal depends on the availability of earliest possible surgical treatment, supplemented by specialized nursing care. The first two years of the Korean War have afforded an excellent opportunity to re-examine methods of treatment and of management of neurosurgical casualties. While matters pertaining to operative technic, employed in those two years, may differ in detail from those used in the two preceding wars, they are in principle based on the teachings of Harvey Cushing and on the experiences in the second world war of American, British and Canadian neurosurgeons. There remained, however, the problem of standardizing a neurosurgical unit which would answer the necessary medical and tactical requirements. Standardization of such a unit for employment in active warfare necessitates a considerable degree of neurosurgical autonomy. A neurosurgical team, attached to a Mobile Army Surgical Hospital (MASH), but functioning autonomously, offers the specialized knowledge, skills and enthusiasms that are imperative in the proper handling of neurosurgical casualties.

It is the purpose of this communication to discuss the organization and functions of the first mobile neurosurgical unit (Third Provisional Neurosurgical Detachment, EUSAK, APO 301) which was established

in the Eighth United States Army in Korea in October, 1951.†

Three basic objectives were sought in the design of this unit.

1. *Earliest possible neurosurgical management* of all casualties with missile wounds of brain and spinal cord so as (a) to relieve compression of cerebral structures and interference with cerebral blood flow in the high percentage of penetrating brain wounds with associated intracranial hematoma, (b) to reduce the incidence of meningocerebral infection, (c) to make specialized neurosurgical nursing available to comatose patients in an effort to reduce mortality and to lessen the incidence of complications, (d) to make specialized neurosurgical nursing measures available to paraplegic patients in an effort to eliminate in them common complications.

2. *Mobility* so as to make neurosurgical care available to the largest possible number of neurosurgical casualties despite the ever changing tactical situation in active warfare. A high degree of mobility permits employment of the team in support of offensive and defensive actions in any given

† This mobile team was first assembled and tested under Colonel Thomas N. Page, MC, USA, Chief Surgeon, Eighth United States Army, during the offensive in the vicinity of Kumsong, Korea, in October, 1951. It was standardized and employed exclusively in the Eighth United States Army under Major General William E. Shambora, Chief Surgeon, Far East Command, who also sponsored the organization of a similar team in the Republic of Korea Army in July, 1952, under the supervision of Brigadier General Tchi Waang Yun, Surgeon General, ROKA.

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sector of the front, as well as in airborne engagements.

3. *Economy* so as to reduce the staggering economic burden of unduly prolonged specialized hospital care. This reduction of morbidity can be achieved by the elimination of those complications which occur almost without fail whenever specialized care is lacking. It may be now stated unequivocally that specialized neurosurgical care, medical and nursing, pays large military dividends, and lightens the ultimate load of veteran care.

PERSONNEL

Neurosurgeons. The requirement of neurosurgical autonomy presupposes the availability of trained and experienced neurosurgeons. The general surgeon cannot be expected to keep abreast of advances which are being made continuously in distinct surgical specialties. Though he may be thoroughly familiar with the technic of neurosurgical emergency procedures, the necessary intimate knowledge of the behavior of cerebral tissue and other intracranial structures under pathological conditions can only be gained on the basis of extensive clinical experience. Such knowledge is of fundamental importance in the operative and in the postoperative management of missile wounds of the brain. Policies with regard to surgical and conservative management should be set forth and carried out by well qualified neurosurgeons who have devoted protracted time and thought to study this field.

In the presence of wounds of the brain and of the spinal cord, the margin between life and death, and that between recovery and invalidism is narrow at best, necessitating careful selection of the personnel which is to be assigned to a neurosurgical team. In his report to the Surgeon General, Eldridge Campbell emphasized this point particularly, "In general, however, it may be opined that the best men should be in the

Far East, that the best men in the Far East should be in Korea, and that the best men in Korea should be in the forward hospitals."*

It requires the mature judgment of an experienced neurological surgeon to command a mobile neurosurgical team in the field. The assistant neurosurgeon should have had at least two years of formal resident training in neurosurgery, preceded by adequate schooling in the basic principles of general surgery. The assignment of a third junior surgeon can be of real value to the team as it would be to any aspiring young surgeon. The tough proving ground of a neurosurgical team in a forward area with its tremendous turnover of casualties with missile wounds of brain and spinal cord provides an ideal training program in the military aspects of neurological surgery.

Anesthetist. Patients suffering from disturbed cerebral physiology require the attendance of a well informed anesthetist. One of us was forced to do most of his work in the second world war under local anesthesia. This is not at all desirable when dealing with penetrating missile wounds of the brain. The authors have benefited a great deal from an exceptionally good anesthesia regimen in the Korean theatre where they had the assistance of highly skilled and experienced anesthetists.

Nurses. Casualties with severe cranio-cerebral trauma are often as dependent for their very survival on adequate nursing care as on adequate surgery. Such nursing care implies specialized training and also a high nurse-patient ratio. Casualties with spinal cord injuries, by the nature of their disability, require a greater number of hours of nursing care than is ordinarily accorded to them in either civilian or military hospitals. Only by such care can complications

* Report of Civilian Consultants in Neurosurgery on Tour in the Far East Command to the Surgeon General, Department of the Army, dated February 11, 1952, page 17, paragraph 11.

be eliminated. In the operating room it is quite feasible, as has been demonstrated by the Third Neurosurgical Detachment in Korea, to employ enlisted surgical technicians rather than nurses. On the wards, however, the nurses' work has proven indispensable.

permit regular duty hours and sufficient time off to prevent exhaustion and undue fatigue of the female officers.

Enlisted Surgical Technicians. A complement of ten enlisted surgical technicians, trained in neurosurgical work, is considered the necessary minimum. This complement

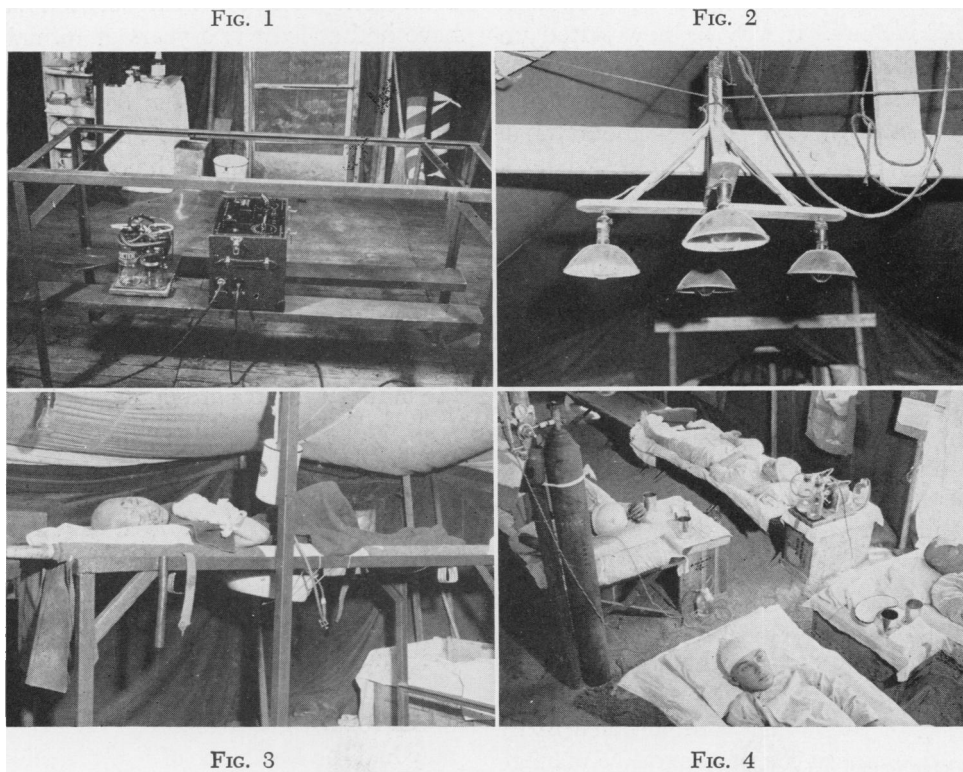


FIG. 1. Ordnance-made metal litter stand as operating table. (Third Provisional Neurosurgical Detachment, EUSAK)

FIG. 2. Operating lamp. (Third Provisional Neurosurgical Detachment, EUSAK)

FIG. 3. Prep stand for casualties with head wounds. Note specially prepared litter for administration of enema. (Third Provisional Neurosurgical Detachment, EUSAK)

FIG. 4. Postoperative Ward Tent. Cubicle arrangement facilitating head dressings, use of one suction apparatus and one oxygen tank for four patients. (Third Provisional Neurosurgical Detachment, EUSAK)

Considering 25 to 35 patients as the average capacity of the described team, four nurses can adequately supervise the pre- and postoperative care, provided that they are specially trained in neurosurgical nursing and that they are supported by a staff of neurosurgically trained and experienced enlisted technicians. A complement of four nurses, assigned to the pre- and postoperative tents of the mobile team will

has been used in the provisional neurosurgical detachments of the Eighth Army and in the newly organized neurosurgical team of the ROK Army.

The excellent results which have been obtained in the provisional neurosurgical detachments of the Eighth United States Army in Korea, and the considerable reduction of morbidity and mortality among neurosurgical casualties during the second

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year of the Korean War can be ascribed largely to the fact that they were afforded the benefits of specialized surgical and nursing care within hours after having been wounded.

work. In the preoperative ward, these men must shave and prepare heads for operation, cleanse wounds, administer blood transfusions, give enemas, catheterize patients, insert indwelling catheters, employ intra-

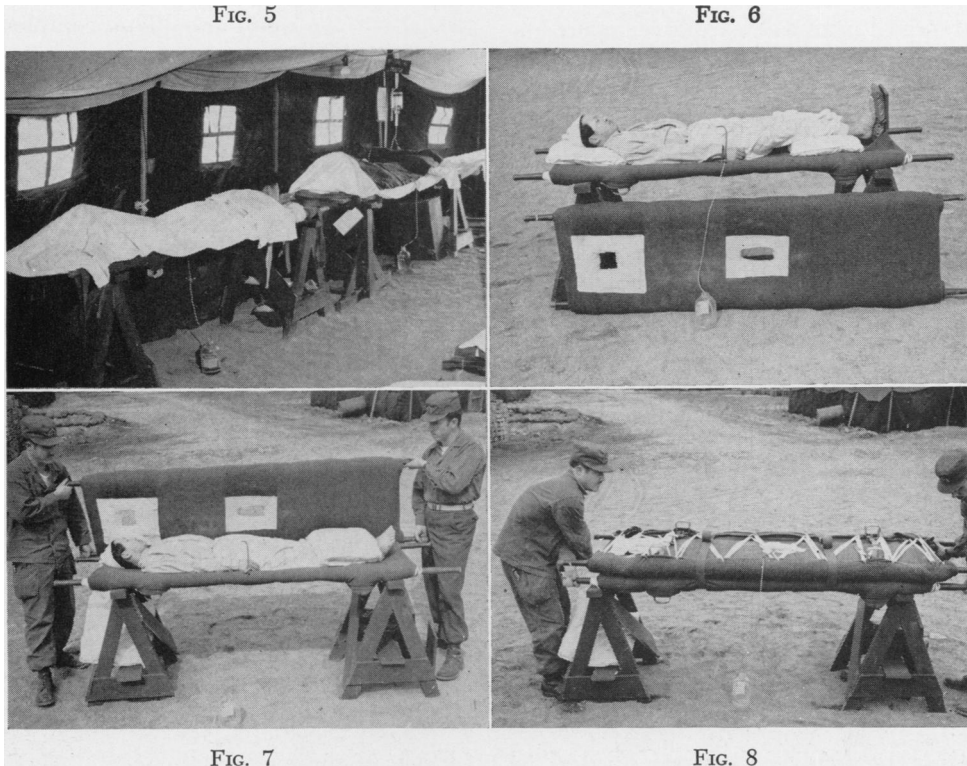


FIG. 5. Postoperative ward tent. Paraplegia section. (Third Provisional Neurosurgical Detachment, EUSAK)

FIG. 6. Litter-Turning-Method for paraplegic patients. Supine position. Padded wooden board is used to prevent foot drop. Note blanket under lower legs to maintain knees slightly flexed and to prevent pressure on heels. (Third Provisional Neurosurgical Detachment, EUSAK)

FIG. 7. Litter-Turning-Method for paraplegic patients. As on a Stryker frame, the patients are turned every two hours, day and night. Specially prepared padded litter for prone position is placed on top of patient. (Third Provisional Neurosurgical Detachment, EUSAK)

FIG. 8. Litter-Turning-Method for paraplegic patients. The two litters are strapped together with the patient still in the supine position. Corpsmen are getting ready to turn the patient. (Third Provisional Neurosurgical Detachment, EUSAK)

Of the ten enlisted surgical technicians, four men are employed in the operating room, each working a 12-hour shift. Of these four technicians, the two most skilled carry out the duties of a scrub nurse; the other two work as circulating nurses or as assistants to the operator.

Six surgical technicians are required to take care of the pre- and postoperative

cheal suction, take blood pressure readings and record other vital signs. The work in the postoperative ward includes the delicate and tedious management of the comatose patient and the time consuming care of the paraplegic casualty.

EQUIPMENT

The Army's "Surgical Instrument Set, Supplemental, Brain and Nerve Injuries"

(9-581-200) includes all essential instruments for the performance of neurosurgical operations of any magnitude in the field. The competent surgeon does not require a wide variety of instruments and can perform craniotomies and craniectomies with this standard army set. A mobile neurosurgical team should be equipped with three such sets in order to facilitate operating on a 24-hour basis as is often necessary. A

rosurgical team should be assigned one such truck and sufficient vehicle space in addition for the transportation of the entire personnel, allowing sudden independent moves from one sector of the front to another at any given time.

PHYSICAL FACILITIES

The employment of tents rather than of available, but usually unsuitable housing structures, provides an organic unit which

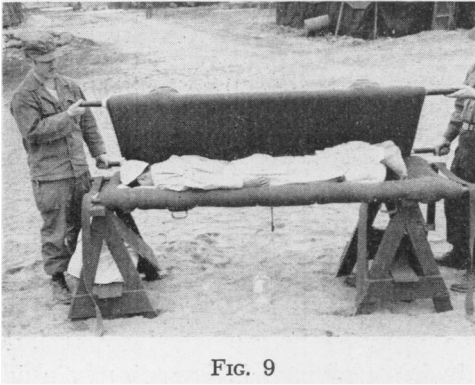


FIG. 9



FIG. 10

FIG. 9. Litter-Turning-Method for paraplegic patients. Upon completion of the turning maneuver, the top litter is removed. Patient is now in prone position. (Third Provisional Neurosurgical Detachment, EUSAK)

FIG. 10. Helicopter evacuation from mobile team to rear of patient with missile wound of right temporal lobe of brain, five days after surgery. (Third Provisional Neurosurgical Detachment, EUSAK)

small number of basic general surgical instruments will be needed in addition to the "supplemental" neurosurgical set.

A portable electrosurgical unit (3-275-600), a portable Heydbrink anesthesia apparatus (3-010-430) and four portable suction machines (3-752-750) are essential items on the list of non-expendable supplies.

Surgical linen, cots, litters, blankets and various housekeeping tools should be furnished by the parent unit to which the team may be attached. The surgical service of that unit can also provide space in the autoclave for the preparation of sterile supplies.

Tentage and equipment, essential for autonomous functioning of the neurosurgical team, can be loaded on one single 2½ ton cargo truck. To assure mobility, a neu-

consists of three closely connected sections. Two hospital tent end sections are used as operating room, providing sufficient space for one or two operating tables and for essential operating equipment. The operating tent is centered between preoperative and postoperative ward tents. The former consists of two hospital tent end sections and one middle section. One corner of the preoperative tent is used solely for the preparation of patients for surgery, leaving sufficient space for four cots and for two paraplegia litter beds for casualties awaiting surgery. The postoperative ward should provide space for 25 to 30 patients, requiring two hospital tent end sections and four middle sections. A Command Post tent is best suited for the preparation and maintenance of records. Additional housing tent-

age for officers and for enlisted men should be allocated to the team.

Operating Tent. The employment in the field of commercial operating tables is costly and impractical. These tables consume space and interfere with mobility. A sturdy metal litter stand (Fig. 1) lends itself well to the performance of craniotomies and laminectomies. Any ordnance unit in

punctures, oxygen therapy, intratracheal suctioning and intravenous administrations. The cubicle arrangement has been found most practical, allowing the use of one suction apparatus for four patients and facilitating ward procedures in general (Figs. 4 and 5). Alternatively cots can be placed in a line, with the heads of the patients facing the middle aisle so as to facilitate head dressings.

Considering the fact that the life expectancy of men afflicted with paraplegia can be as good as that of other individuals, so long as such common complications as decubital ulcers, bladder overdistention, bladder infection and hypoproteinemia are prevented, the importance of immediate availability of proper care for this group of casualties scarcely needs emphasis. The employment of Stryker frames in the field is

TABLE I.

Neurosurgeon.....	MOS B-3131	1
Assistant Neurosurgeon.....	MOS C-3131	1
Assistant Surgeon.....	MOS D-3131 (or D-3150)	1
Anesthetist.....	MOS C-3115	1
Nurses.....	MOS 3434	4
Enlisted Surgical Technicians.....	MOS 2861	10

the field can make such a stand from scrap iron. Craniotomy in the supine and lateral position can be carried out on a padded litter, placed on such a metal stand. The head can be positioned with blankets and secured with adhesive tape. Suboccipital operations and laminectomies require a litter with a circular hole for the face, enabling the anesthetist to control the air passages. Standard field operating lamps do not furnish a satisfactory lighting device for neurosurgical procedures. They are bulky, consume space and interfere with mobility. A practical surface light which can be moved on a cross beam from head to spine, as illustrated in Fig. 2, can be hand made without difficulty. Supplemented by a head light or by Frazier lighted retractors for the illumination of deep structures, this lamp has been found effective for field use.

In the tent for preoperative patients, a similar metal litter stand as that used in the operating room lends itself well as a preparation stand. Specially adapted litters facilitate thorough preparation of the head, catheterization and administration of an enema (Fig. 3).

The postoperative ward tent can readily be arranged so as to provide the necessary space for head dressings, flap taps, lumbar



FIG. 11. Evacuation bag for helicopter evacuation of casualties in winter time. (Third Provisional Neurosurgical Detachment, EUSAK)

impractical because of time consuming maintenance and because of the space which the frames require; their use by a team in the field would interfere with mobility. During the fighting at the Chosin Reservoir in November, 1950, Major Clifford P. Goplerud and Major J. L. Girardeau of the United States Army Medical Corps employed the litter-turning method on a quadriplegic patient of one of the authors for the first time. Further experience led to

improvement of this method and its standardization. The exclusive use of the two-hourly litter-turning-method in the Third Neurosurgical Detachment during the period October, 1951, to August, 1952, was responsible for the fact that decubital ulcers did not develop in any American or UN patient. The litter-turning-method requires blanket padded litters which are placed on saw horses. Two hourly turnings are effected by placing a second litter on top of the patient and strapping him between the two litters. On completion of the turn, the top litter is taken off, cleansed and aired. For the prone position, the litter is specially prepared with an opening for the face and one for the catheter (Figs. 6, 7, 8, 9).

TACTICAL EMPLOYMENT

The provisional neurosurgical teams employed by the Eighth Army in Korea are dependent for housekeeping purposes on the hospital unit to which they are attached. Their physical facilities permit the operative and postoperative management of all casualties with missile wounds of brain and spinal cord. Direct evacuation of these casualties from the Battalion Aid Station to the team by helicopter has been an essential factor in the achievement of earliest possible definitive care. By attaching the mobile teams to the most advanced hospital units, specialized care is not delayed by admission to intermediate hospitals which may not be equipped to treat neurosurgical casualties.

In the Korean War, the Mobile Army Surgical Hospital (MASH) is the Eighth Army's most advanced hospital in the chain of evacuation and is ideally suited as a parent unit for mobile neurosurgical teams. Direct helicopter evacuation to the MASH from the Battalion Aid Station as it is also used for other casualties with critical wounds, provides the fastest and safest transportation for patients with brain and spinal cord wounds. The elimination of

poorly tolerated ambulance rides over rough roads is an added advantage which cannot be overestimated.

The Neurosurgical Center at the Tokyo Army Hospital provides the second echelon for all neurosurgical casualties in the Far East Command. Those with missile wounds of the brain can safely be evacuated to the rear within three to seven days after definitive surgery has been performed. Uncomplicated penetrating brain wounds tolerate the trip quite well within three to four days; transventricular wounds, however, fare better if held for a few days longer. Casualties with spinal cord trauma, barring associated wounds of abdomen or chest, can be transported safely three to four days following laminectomy.

The Eighth Army in Korea has adopted the policy of evacuating all neurosurgical casualties from the mobile team at the MASH by helicopter (Fig. 10) to the nearest airport, and from there by C-54 directly to Tokyo, eliminating intermediate hospital admission and ambulance rides on rough roads. The Army Quartermaster's new winter evacuation bag (Fig. 11) permits helicopter evacuation even at subzero temperatures. This evacuation system, in effect in the Far East Command since October, 1951, has been an essential factor in the smooth functioning of the team. It is exemplary and can hardly be equalled.

Ideally an army in the field should have one mobile neurosurgical team for each corps. Such a team could then move within the corps boundaries in accordance with the demands of the tactical situation. If at all feasible, one additional team should be kept in reserve to lend support wherever needed. The availability of a reserve team would also allow each of the teams an occasional rest period.

So as to facilitate personnel administration and procurement of supplies, one Medical Corps Service Officer and one clerk could be charged with the administrative

supervision of all neurosurgical teams in one army.

DISCUSSION

Experiences in the second World War and in the Korean War have amply demonstrated the need of a special organization for the management of neurosurgical casualties. The two-echelon system which is presently employed in the Far East Command for the management of all casualties with missile wounds of brain and spinal cord answers that need. The incidence of meningocerebral infection was as high as 41 per cent during the early phase of the Korean War when it was necessary to delay specialized neurosurgical care until the patients reached Tokyo. The adoption by the Army Medical Corps of the two-echelon system with mobile neurosurgical teams rendering definitive treatment at division level, reduced the incidence of meningocerebral infection to less than 1 per cent.

Of all missile wounds of the brain admitted to the Third Provisional Neurosurgical Detachment during a ten-month period, 49 per cent had clinically significant intracranial hematomas displacing midline structures sufficiently to have become fatal unless they were removed within a few hours after the trauma had been sustained. We surmise, therefore, that the realization of earliest possible neurosurgical intervention in the second year of the Korean War has

spared the lives of many men who could not have stood the trip back to a rear installation. The employment of helicopter evacuation has been an essential factor in the successful work of the mobile neurosurgical teams.

The use of substitute Stryker frames (litter-turning-method) for the early care of paraplegic and quadriplegic casualties has eliminated the occurrence of decubital ulcers, a complication which has been largely responsible in the past for the high morbidity among paraplegias.

The maintenance of an adequate program for patients with missile wounds of brain and spinal cord in active warfare, in the final analysis, is dependent on the experience, the skill and the enthusiasm of the team of people charged with the responsibility for this group of casualties. Military exigencies, however, necessitate a structural organization, centralizing specialized care and special facilities. The mobile neurosurgical teams which have been employed on a provisional basis by the Eighth United States Army in Korea and by the Republic of Korea Army, furnish such structural organization, and provide the exceptional care of neurosurgical casualties of which the Army Medical Corps has proven itself capable.

The illustrations have been prepared by Sergeant Raymond W. Craig, U. S. A., Medical Art Section, 406th Medical General Laboratory, APO 500, c/o Postmaster, San Francisco, California.