An Analysis of
2811 Chest Casualties of the Korean Conflict

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In this paper we present an analysis of the 2811 chest casualties of the Korean Conflict which were treated at Tokyo Army Hospital between the beginning of the war and March 1953. A previous report covering 1535 of these casualties has been published. However, this paper adds more than 1000 cases and contains data which was not available at the time of the previous report. Some conclusions are repeated because additional experiences only served to bear out their validity.

Tokyo Army Hospital was the center for treatment of thoracic casualties. Approximately 85 per cent of our patients were United States military personnel and 15 per cent were members of forces contributed to the Korean effort by other United Nations.

During the first few months of the conflict, definitive treatment could not be administered overseas because casualties could be hospitalized in the theater only 30 days. However, as the bed capacity increased, the period of hospitalization was increased to 120 days, making definitive treatment possible.

In this series we have included only those patients who suffered injuries to the intrathoracic viscera and do not include those with only superficial wounds of the chest. Of these wounds, 1968 (70 per cent), were of the penetrating type, 787 (28 per cent), of the perforating type and 56 (2 per cent), were results of crushing injuries.

Hemothorax

The most frequent complication of intrathoracic wounds is hemothorax with or without associated pneumothorax. This intrapleural blood may remain fluid or may coagulate and begin to organize. In this series 1744 patients (52 per cent) had hemothoraces either on admission or developed them within the first two weeks after admission. Of this number 1291 (74 per cent) remained sterile and 453 (26 per cent) became infected.

We treated hemothorax by simple thoracentesis without air replacement. Following removal of the fluid, 300,000 units of crystalline penicillin and 1 Gm. of streptomycin were instilled. The procedure was repeated every 24 hours, or more often if indicated, until no fluid could be obtained and the chest appeared normal to physical and x-ray examination. Specimens of the fluid removed were sent to the laboratory for culture, antibiotic sensitivity tests, and other studies as indicated. If infection was present, the antibiotic of choice was administered systemically and intrapleurally, depending upon the manner in which the drug could be administered.

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FIGURE 1, (Case 1): This patient received a penetrating wound of the right posterior chest. This picture shows a large shell fragment in the right lower chest. There is also a large cavity containing fluid and air.—Figure 2, (Case 1): Lateral view of the same patient showing the shell fragment posteriorly.—Figure 3 (Case 1): Same patient after a right total pneumonectomy and partial thoracoplasty. Patient is doing well one year after surgery.
Penicillin, streptomycin, terramycin, aureomycin, and chloramphenicol were utilized.

Eighty per cent, or 1895 patients, completely recovered after being treated by thoracenteses and antibiotics only. Sixty-eight per cent were returned to duty and the remainder were evacuated to the zone of interior because of other wounds although they were recovered as far as their chests were concerned.

Many patients had clotted hemothoraces on admission to the hospital or within two days after being wounded. From a review of their records, it would seem that the hemothorax clotted within a few hours after wounding, because at no time was any fluid obtained by aspiration. In others the hemothorax coagulated gradually, taking from three or four days to two weeks.

Decortication is the established method of treatment for those patients with significant clotted or organized hemothoraces. A total of 254 decortications were performed on patients with both infected and non-infected organized hemothoraces. Of these, 76 per cent were infected and 24 per cent were noninfected. Ninety-one per cent were considered as having excellent results, 4 per cent having fair results, and 5 per cent as poor results.

It is noteworthy that 92 per cent of the patients who needed decortication had closed intercostal drainage tubes inserted in Korea. We feel that closed intercostal drainage has many disadvantages as an early treatment for hemothorax. It increases the hazards of evacuation, since the tubes are often found improperly clamped off and fluid from the bottles is sucked back into the chest. Furthermore, in hemothorax, closed drainage usually loses its value within 24 to 36 hours because of occlusion of the tube by fibrin and clots and by pleural adhesions about the intrathoracic portion of the tube.

After performing decortications at intervals of one to eight weeks following injury, it was decided that the optimum time for such operation is within three to five weeks after injury. From a review of the reports published by surgeons who had experience in treating chest casualties during World War II, it would seem that there is general agreement upon this interval. In those operations performed early, the bleeding is much more severe, there is more edema, and foreign bodies, if present, are more difficult to locate.

In 18 cases we used streptokinase and streptodornase according to the procedure described by Tillett and Sherry. We obtained such poor results that their use was discontinued.

Foreign Bodies

It was the policy at Tokyo Army Hospital to remove only those foreign bodies which exceeded 1.5 cm. in their greatest diameter, unless, of course, they were in such a location as to be regarded as dangerous to the patient, cause some pathologic changes within the chest, or produced symptoms. Persistence or development of reaction about the missile indicated the
need for exploration and removal.\textsuperscript{1,2}

Three hundred and twenty-seven patients had retained foreign bodies which necessitated removal. Approximately 85 per cent of these were shell fragments which varied in size from 1 cm. to 9 cm. in diameter and the remaining 15 per cent were bullets of various calibre. When the foreign body was a shell fragment the incidence of infection was high, running from 60 to 70 per cent. When the foreign body was a bullet, the incidence of infection was about 10 per cent.

Among the 327 patients operated on at Tokyo Army Hospital solely for the removal of foreign bodies, the postoperative empyema incidence was only 2 per cent. The majority of these patients returned to duty, but a small number had to be returned to the zone of interior because of other wounds.

We found that delaying the operation for removal of foreign bodies for two to three weeks, if possible, decreased the amount of bleeding at operation and made location of the foreign body easier. Also the patient was usually in much better condition to tolerate the thoracotomy procedure. In reviewing the records, we also found that the empyema incidence among some 150 patients who were operated upon in forward areas for removal of foreign bodies was 25 per cent.

\textit{Mediastinal Injuries}

One hundred seventeen or slightly more than 4 per cent of our patients suffered mediastinal wounds. The majority of them also had retained...
metallic foreign bodies. Approximately 65 per cent developed infections which were drained through the pleural space.

We removed 32 foreign bodies from the mediastinum, 10 from the pericardium, and 16 from the myocardium. Three had foreign bodies in the intraventricular septum which we did not remove.

Forty-two developed pericardial effusions which were treated with pericardiocenteses and antibiotics. Pyogenic organisms were obtained from culture of the aspirated fluid in about 40 per cent of the cases.

The following table shows the extent to which other structures in the mediastinum were injured:

<table>
<thead>
<tr>
<th>Structure</th>
<th>Cases</th>
</tr>
</thead>
<tbody>
<tr>
<td>Esophagus</td>
<td>9</td>
</tr>
<tr>
<td>Aorta</td>
<td>8</td>
</tr>
<tr>
<td>Thoracic Duct</td>
<td>5</td>
</tr>
<tr>
<td>Vena Cava</td>
<td>3</td>
</tr>
<tr>
<td>Trachea</td>
<td>5</td>
</tr>
</tbody>
</table>

The majority of these patients, with the exception of those with injuries to the heart and great vessels, were returned to duty in the theater.

**Thoraco-Abdominal Wounds**

It was our experience that many cases with thoraco-abdominal wounds involving the upper abdomen could be handled adequately through the thoracotomy. The exposure is good and it obviates the necessity of an abdominal or thoraco-abdominal incision. We found that patients who needed extensive abdominal surgery made better progress when separate thoracotomies and laparotomies were done than when a thoraco-abdominal incision was made. Also, infection, if it developed, was more localized when separate incisions were made.

Generally patients who suffered injuries to the diaphragm and spleen in conjunction with their chest wound had these injuries repaired at the time of the thoracotomy. We repaired 186 injuries to the diaphragm and performed eight splenectomies. The majority of these patients were returned to duty in the theater.

Patients with serious liver damage, multiple intestinal perforations, with or without resection, colostomies, nephrectomies, etc. were evacuated to the zone of interior for definitive chest surgery. If necessary the temporizing procedure of open drainage with rib resection was carried out so that they could be safely evacuated.

The table below gives the extent to which various abdominal organs were injured.

<table>
<thead>
<tr>
<th>Organ</th>
<th>Cases</th>
</tr>
</thead>
<tbody>
<tr>
<td>Liver</td>
<td>201</td>
</tr>
<tr>
<td>Spleen</td>
<td>82</td>
</tr>
<tr>
<td>Large intestine with colostomy</td>
<td>52</td>
</tr>
<tr>
<td>Small intestine</td>
<td>18</td>
</tr>
<tr>
<td>Stomach</td>
<td>48</td>
</tr>
<tr>
<td>Kidney</td>
<td>43</td>
</tr>
</tbody>
</table>

Approximately 15 per cent of our patients suffered wounds involving both the chest and abdomen. Four deaths, or slightly less than 25 per cent of our mortality, were in this group.
Figure 6, (Case 2): This patient received a penetrating wound of the left lateral chest. This picture shows a left organized hemothorax with a 45 caliber bullet in the left lower chest.—Figure 7, (Case 2): Same patient showing an organized hemothorax and a 45 caliber bullet in the left lower posterior chest.—Figure 8, (Case 2): Same patient after left decortication and removal of bullet. Patient went back to duty and is doing well two years after surgery.
Other Injuries

A large number of our patients suffered nerve injuries and/or orthopedic injuries along with their chest wounds. Those whose injuries were so serious that there was little likelihood of their returning to duty in the theater usually received only palliative treatment, such as thoracentesis or thoracotomy drainage with rib resection, and were then evacuated to the zone of interior.

Bacteriology

Many kinds of bacteria were isolated on culture of the fluid aspirated from the chests of our patients. In the beginning, the infection was usually a mixed one, made up of various gram-negative rods and gram-positive cocci. However, as antibiotic treatment continued the gram-negative bacilli, such as E. coli, E. freundii, Aerobacter aerogenes, pseudomonas aeruginosa, various proteus species, etc., were usually destroyed, leaving only the gram-positive cocci to be dealt with.

Hemolytic and non-hemolytic streptococci were isolated in a number of cases, but by far the most common and most persistent organism encountered was hemolytic, salt-resistant, mannitefermenting (coagulase positive) staphylococcus. The streptococci were easily controlled by antibiotics, but usually the staphylococcus became resistant to all antibiotics except chloramphenicol in very high concentrations.

We found various types of proteolytic clostridia in a number of cases which could account for the massive destruction of lung tissue found.

Morbidity

The prime factor in the treatment of chest casualties is the restoration of normal cardio-respiratory physiology as soon as practicable. All such procedures as thoracentesis, decortication, removal of foreign bodies and irreparably damaged lung tissue, repair of the diaphragm and the chest wall help restore normal function and decrease morbidity.

We feel that physiotherapy is an important adjunct in decreasing morbidity. If possible, it is started on the third postoperative day. The patients begin with breathing exercises and blow into bottles and engage in passive and active exercise of the shoulder and arm of the operated side simultaneously.

The period of hospitalization, in most instances, varied from three to six weeks. Following discharge from Tokyo Army Hospital, patients who were considered candidates to return to duty in the theater were sent to Camp King. This camp was a convalescent and reconditioning center. It was operated under medical supervision and the amount of activity was gradually increased to combat peak. Patients who could not stand the rigors of combat conditions were weeded out and sent to limited duty.

Approximately 80 per cent of the chest casualties who had definitive treatment at Tokyo Army Hospital returned to duty in the theater. A considerable number who had to be evacuated eventually returned to duty, but we have no data concerning them.
Figure 9, (Case 3): This patient received a penetrating wound of the left posterior chest. This picture shows a small shell fragment in the left upper chest and a round encapsulated hematoma of the left lower lobe. — Figure 10, (Case 3): Lateral view of the same patient showing the shell fragment in the left upper chest and the round hematoma of the dorsal segment of the left lower lobe. — Figure 11, (Case 3): This picture shows the same patient after removal of foreign body and segmental lobectomy.
Mortality

It is assumed that the initial mortality in thoracic wounds must be high, but we have no overall figures regarding the mortality of chest wounds in the Korean conflict. However, the delayed mortality appears to be lower than might be expected. Our overall mortality at Toyko Army Hospital was 0.6 per cent and that reported for the Yokasuka Naval Hospital was 1.9 per cent.7

We had 17 deaths in 2811 cases. Eight of them died as a result of serious wounding: four died of thoraco-abdominal wounds, one of pulmonary embolism, one of cardiac tamponade, and two from serious nerve injuries. Nine of our deaths were due to homologous serum hepatitis. Many others, all of whom had received numerous transfusions of plasma and whole blood, developed jaundice but did not succumb.

More than 800 major operations, excluding thoracotomy drainages, were performed without a death.

- Decortications 254
- Lobectomies and partial resections 169
- Pneumonectomies 5
- Splenectomies 8
- Thoracotomies for removal of foreign bodies, etc. 435

Many factors contributed to this low mortality. We had the benefit of the experience of the chest surgeons in the rather recent World War II; we had more and improved antibiotics; there was plasma and whole blood readily available for transfusion near the battle lines; the Mobile Army Surgical Hospitals could do major surgery if necessary just a few miles from the front lines; evacuation was very rapid. Lastly, but of great importance, the patients were healthy young men with an average age of 23 years.

Late in the war protective vests were introduced which helped decrease the mortality of chest wounds. They were most effective in stopping low velocity missiles and many soldiers who would have been instantly killed if not protected by the vest, were only wounded.
CONCLUSIONS

Our experience with 2811 chest casualties indicates that, in general, the best early treatment for chest wounds is the most conservative one.

Thoracentesis is the most effective treatment for hemothorax. Approximately 80 per cent of the patients with hemothorax were cured by thoracentesis and antibiotic treatment. We feel that closed intercostal drainage is seldom necessary and often dangerous. Ninety-two per cent of those patients who required decortication had intercostal drainage tubes inserted in Korea.

Decortication is the accepted treatment for clotted or organized hemothorax and the best results were obtained by performing this operation within from three to five weeks following injury. The optimum time for removal of foreign bodies is within two to three weeks after injury.

We found breathing exercises and physical therapy helpful in reducing morbidity.

We estimate that approximately 90 per cent of the casualties who suffered chest wounds only were returned to duty.

CONCLUSIONES

Nuestra experiencia con 2811 lesiones de tórax, indica que en general, el mejor tratamiento inmediato para las heridas de tórax, es el conservador.

La toracentesis es el medio más efectivo para el hemotórax.

Aproximadamente el 80 por ciento de los enfermos con hemotórax, se curaron con toracentesis y antibióticos. Creemos que el drenaje intercostal cerrado rara vez, es necesario y a menudo es peligroso. Noventa y dos por ciento de los enfermos que requirieron decorticación, tenían tubos que se les habían insertado en Corea.

La decorticación es el tratamiento aceptado para el hemotórax coagulado u organizado y los mejores resultados se obtienen realizando la operación dentro de tres a cinco semanas después de la herida. El tiempo óptimo para extraer cuerpos extraños, es de dos a tres semanas después de la herida.

Encontramos que los ejercicios respiratorios y la fisioterapia, es útil para reducir la morbibilidad.

Estimamos que aproximadamente el 90 por ciento, de los que sufrieron heridas de tórax solamente, volvieron al servicio.

RESUME

L'auteur développe l'expérience qu'il a acquise par l'étude de 2.811 accidents ayant touché le thorax. En général; le meilleur traitement d'urgence pour les blessures thoraciques est celui qui se montre le plus conservateur.

Pour l'hémothorax; c'est la thoracenthèse qui est la thérapeutique la plus efficace. Environ 80% des malades atteints d'hémothorax furent guéris à l'aide de la thoracenthèse associée aux antibiotiques. L'auteur estime que le drainage intercostal à pière fermée est rarement nécessaire, et se montre souvent dangereux. 92% des malades pour lesquels une
décortication pleurale était nécessaire, avaient été l’objet d’un drainage inter-costal pratiqué en Corée.

Le traitement qui s'impose pour les hémothorax coagulés et organisés est la décortication. C’est en réalisant cette opération dans le cours de trois à cinq semaines, suivant la blessure, que l’on obtint les meilleurs résultats. Le meilleur moment pour procéder à l’ablation d’un corps étranger se situe entre deux à trois semaines après la blessure. L’auteur a constaté que les exercices respiratoires et la physiothérapie furent d’un grand secours pour éviter les suites pathologiques.

Il estime qu'environ 90% des cas de blessures exclusivement localisées au thorax ont permis la reprise de l’activité.

REFERENCES
7 King, James D., Commander, USN and Harris, James H., Lt., USN: "War wounds of the chest among Marine and Naval Casualties in Korea," S. G. O., 97:199, 1953.