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MILITARY ANTI-SHOCK TROUSER

BY

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U. S. ARMY AEROMEDICAL RESEARCH LABORATORY

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Acute hypovolemia may occur with blood loss, fluid shifts within tissue compartments, and vasodilatation. Pre-hospital treatment has consisted of positioning patient, control of environment, oxygen administration, wound dressing, and, more recently, intravenous fluid administration and/or vasopressors. Few studies demonstrate on-site efficacy of intravenous fluid therapy in terms of time factors, quantities administered, and effect periods. Even more controversial are the effects of pressor agents in such states as a primary method of choice. The US Army's Aeromedical Research Laboratory at Fort Rucker, Alabama, has produced an anti-shock garment of novel design which is extremely fast and easy to apply, fits nearly all size and body configurations, and is extremely effective. It has been evaluated by City of Miami Fire Rescue in a series of trauma cases involving lower extremity, pelvis, and abdomen. It results in prompt return of vital signs in the patient where neither pulse nor blood pressure were obtainable. The time of application and return of vital signs has been less than three minutes in all cases. Although intravenous fluids also were started, the amount administered was less than 100 cc in each case cited. The device enables some degree of autotransfusion from each lower extremity, while at the same time limiting the circulation to the lower half of the body. Its effect in states of cardiac arrest remains to be defined. By its shunting action, it might be extremely beneficial by diverting marginal cardiac output to the upper body and brain. The device is shown and cases regarding its use are presented.		

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ABSTRACT

Acute hypovolemia may occur with blood loss, fluid shifts within tissue compartments, and vasodilatation. Pre-hospital treatment has consisted of positioning patient, control of environment, oxygen administration, wound dressing, and, more recently, intravenous fluid administration and/or vaso-pressors. Few studies demonstrate on-site efficacy of intravenous fluid therapy in terms of time factors, quantities administered, and effect periods. Even more controversial are the effects of pressor agents in such states as a primary method of choice.

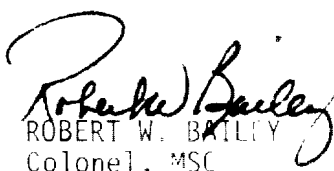
The US Army's Aeromedical Research Laboratory at Fort Rucker, Alabama, has produced an anti-shock garment of novel design which is extremely fast and easy to apply, fits nearly all size and body configurations, and is extremely effective. It has been evaluated by City of Miami Fire Rescue in a series of trauma cases involving lower extremity, pelvis, and abdomen. It results in prompt return of vital signs in the patient where neither pulse nor blood pressure were obtainable. The time of application and return of vital signs has been less than three minutes in all cases. Although intravenous fluids also were started, the amount administered was less than 100 cc in each case cited.

The device enables some degree of autotransfusion from each lower extremity, while at the same time limiting the circulation to the lower half of the body.

Its effect in states of cardiac arrest remains to be defined. By its shunting action, it might be extremely beneficial by diverting marginal cardiac output to the upper body and brain.

The device is shown and cases regarding its use are presented.

APPROVED:


ROBERT W. BAILEY
Colonel, MSC
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MILITARY ANTI-SHOCK TROUSER

USE

The "anti-shock trouser" is a development of the United States Army Aeromedical Research Laboratory (USAARL) for the treatment of hypovolemic shock and blunt abdominal trauma. It affords the user an immediate means to stabilize patients prior to transportation either by ground or air ambulance.

The trouser will temporarily arrest bleeding from lacerated abdominal blood vessels and organs traumatized as a result of gunshot, knifing, or blunt injuries. In addition, the trouser acts as a natural pressure dressing and splint when applied to the lower extremities and pelvic areas. It may also be used to control postpartum hemorrhage and may be applied over splints. The anti-shock trouser could possibly prevent bleedout from occurring in the lower half of the body, augments venous return, maintains central circulation, and allows brain perfusion. In areas where intravenous (IV) therapy cannot be used or is not available, the trouser is indispensable. For rapid stabilization prior to transport, the trouser should be applied prior to the starting of an IV infusion.

The trouser should not be removed until the physician-in-charge has made adequate preparation for blood transfusion, X-rays taken, and operating room prepared. Then, and only then, should pressure be slowly released in order to prevent the victim from returning to the shock state. As long as the patient is stabilized, adequate preparation prior to surgery is recommended.

OPERATING INSTRUCTIONS

The anti-shock trouser is a one-piece polyvinyl coated nylon material which is capable of being inflated to a pressure of 104 mm Hg (Figure 1). Prior to being inflated, the hypotensive victim is placed on the material up to, but not including, his rib cage. The material corresponding to the patient's left lower extremity is wrapped around the extremity and secured with Velcro strips. The material corresponding to the abdominal area is then put in place and secured with Velcro. The material corresponding to the right lower extremity is then put in place and secured with Velcro. The trouser is then inflated by means of a foot-pump that is connected to a Y-tube and two two-way valves located at the distal ends of each extremity. The trouser is inflated until the Velcro fasteners begin to crackle and/or the patient's vital signs become stable. The air valves are then closed

and the Y-tube and pump assembly disconnected from the anti-shock trouser. The victim is now ready for transportation either by ground or air ambulance (Figure 2).

SAFETY FEATURES

The anti-shock trouser incorporates a safety valve which allows air to escape at a pressure of approximately 107 mm Hg and which will automatically seal again at a pressure of 100 mm Hg. Usually the Velcro fasteners will begin to crackle before this stage is reached.

CAUTION: DO NOT INFLATE TROUSER IN THE OPEN POSITION AS SEALS MAY FAIL. ALWAYS SECURE VELCRO ATTACHMENTS BEFORE INFLATION.

MECHANISM

The anti-shock trouser is capable of exerting 100 mm Hg counterpressure (external) from the lower extremities up to and including the abdominal wall. Pooled venous blood is squeezed out of the lower extremities and abdominal areas augmenting venous return to the right heart. In addition, venous pooling is prevented and peripheral resistance increased in the lower half of the body. Blood then becomes available to the upper half of the body preserving perfusion of the brain, and the patient becomes stable.

CONTRAINDICATIONS

The anti-shock trouser is not to be used in patients who are in pulmonary edema or those patients or victims who are not in a state of shock.

EVALUATION AND RESULTS

Two prototypes were manufactured* and sent to the University of Miami School of Medicine's Emergency Medical Services under the direction of Dr. Eugene Nagel for evaluation and use by the Miami Fire Rescue paramedical personnel.

This location was chosen because of its high incidence of trauma, excellent paramedical support, and its proximity to USAARL.

*Dave Clark Company, Worcester, MA

The following six cases are representative of the results currently being obtained and were extracted by Drs. E. Nagel, J. Civetta, and S. Nussenfeld.

Case #1: This 39-year-old woman suffered an upper abdominal gunshot wound. Rescue arrived and their initial vital signs showed a blood pressure of 70 palpable systolic. The MAST garment was applied, an IV of D5 lactated Ringer's solution initiated, and the blood pressure then obtained was 110 systolic. She was rushed to the hospital and prepared for surgery. In the operating room after transfusions had been started, the MAST suit was deflated and the abdomen quickly entered. Approximately 1,500 cc of blood was present in the peritoneal cavity. There was bleeding from the gastric artery, pancreas, and the left kidney was fractured by the bullet. A splenectomy, distal pancreatectomy, and control of arterial bleeders were performed. The postoperative course was uneventful.

Case #2: This 42-year-old male received two bullet wounds in his back, with one exiting the anterior abdominal wall. Initial blood pressure taken by Rescue was 80/60. The patient was placed in the MAST garment and it was inflated, with blood pressure immediately rising to 100/72. It gradually rose during the transportation to 130/80. In the emergency room, additional fluids were given to a total of 3,000 cc of Ringer's lactate and the patient was transported to the operating room with the MAST garment inflated. When the garment was removed, blood pressure remained at 100 systolic and the abdomen was surgically explored. Approximately 3,000 cc of blood was in the free peritoneal cavity. There was major bleeding from the proximal jejunal arcade as well as small and large bowel perforations. Bleeding was controlled and small bowel resection was performed. Postoperatively, the patient did well.

Case #3: This 60-year-old male was hit by a car. On examination by Rescue he was semiconscious, and had an obvious fracture of his femur and tenderness on palpation of his pelvis. Blood pressure was 80/60, pulse 100, respirations 24. The MAST garment was applied, blood pressure immediately rose to 110/70 and patient became conscious. An IV of 5% D lactated Ringer's was started and the patient was then transported to the emergency room where X-rays were obtained including an intravenous pyelogram. The MAST suit was deflated after suitable volume loading. The blood pressure dropped

to 90 systolic, which responded to continued infusion of blood. Because of absence of right femoral pulse, displacement of the bladder to the right and a urethral tear, it was elected to explore the patient. A large retroperitoneal hematoma was found. Occlusion of the right external iliac artery due to an atheromatous plaque was discovered. A suprapubic cystostomy was done. The patient gradually stabilized from his pelvic fracture with infusion of nine units of blood over the first 24 hours. Hematologically, the patient remained stable, although a picture consistent with fat embolization ensued.

Case #4: This 50-year-old male received two abdominal gunshot wounds. Initial blood pressure was noted to be 60 systolic. A MAST suit was inflated, following which blood pressure immediately rose to 120 systolic. The patient was alert and responsive and was taken to the emergency ward in stable condition. After infusion of 2,000 cc Ringer's lactate and stabilization, patient was transported to the operating room with G-suit inflated. Anesthesia was induced, the G-suit deflated, and blood pressure remained stable. The abdomen was explored; approximately 1,500 - 2,000 cc of free blood was encountered with multiple small bowel and mesenteric lacerations. Hemostasis was obtained and two involved loops of small bowel were resected because of the interference of the blood supply and the multiple perforations. The patient had a stable postoperative course.

Case #5: Rescue found a 27-year-old male with fractures and crush injury to both lower extremities. Pain appeared extreme, and the victim was semiconscious. No pulse or blood pressure could be obtained by auscultatory, oscillometric, or palpable means. The lower extremities were splinted, MAST garment applied, and an IV with D5 lactated Ringer's begun with vital signs promptly returning: Blood pressure 122/74, pulse 50, and good respiration. The patient's consciousness level returned, also, and he reported great relief of pain with application of the MAST garment. The patient was then transported to the hospital where he was subsequently X-rayed and no fractures observed. The MAST garment was removed (BP 130/70, pulse 80). Blood pressure remained stable and pulse increased to 100. Both lower extremities were wrapped in ace bandages and hypothermia (ice) was applied. Debridement was done and in-hospital course uneventful.

Case #6: Rescue found a 38-year-old male with almost

total amputation of right lower extremity. Blood loss was extreme, patient was semiconscious with no pulse, and possible oscillometric indication of blood pressure at 60 systolic. Tourniquet was applied to stump, MAST garment applied, IV 5% lactated Ringer's begun, and repeat vital signs 75/50, good pulse and patient fully conscious and responsive. At the hospital the MAST garment was removed prior to blood being cross-matched, volume replaced, and additional IV's secured. Vital signs were lost and shock ensued. Patient expired three days postop secondary to aspiration pneumonia.

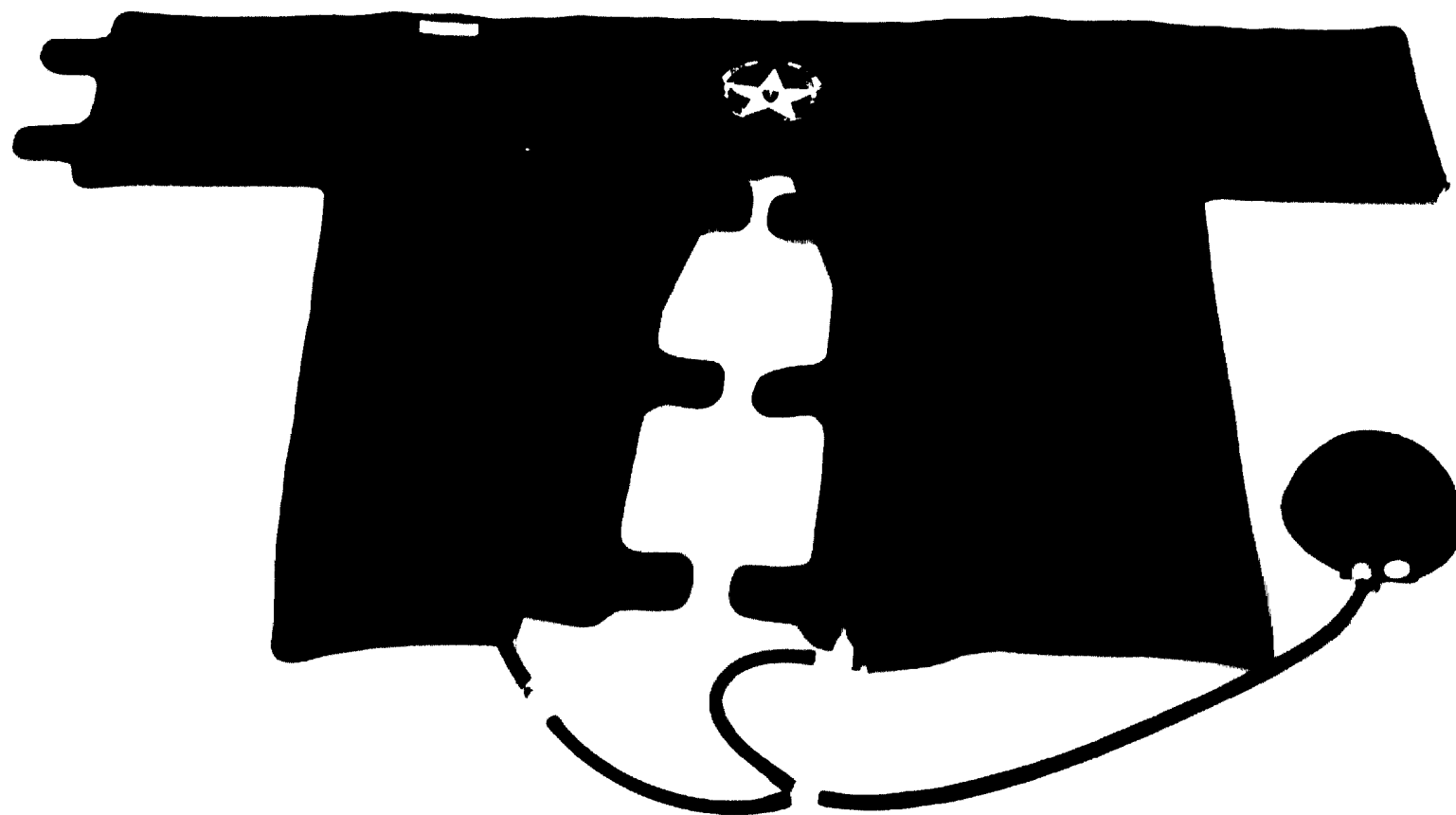


FIGURE 1. Military Anti-Shock Trouser

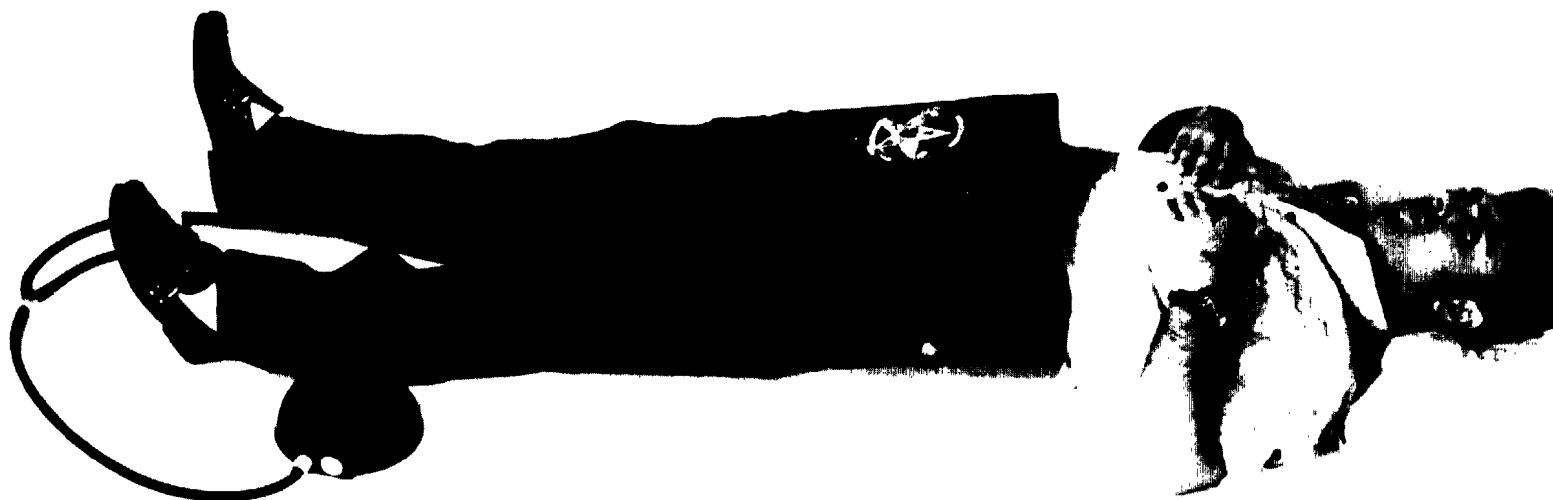


FIGURE 2. A Simulated Patient With The Military Anti-Shock Trouser In Place And Ready For Transportation