Rehabilitation of landmine victims — the ultimate challenge

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Abstract Antipersonnel landmines are often used indiscriminately and frequently result in injury or death of non-combatants. In the last 65 years, over 110 million mines have been spread throughout the world into an estimated 70 countries. Landmine victims use a disproportionately high amount of medical resources; the vast majority of incidents occur in regions and countries without a sophisticated medical infrastructure and with limited resources, where rehabilitation is difficult in the best of circumstances. It is suggested that only a quarter of the patients with amputation secondary to landmines receive appropriate care.
Keywords Blast injuries/rehabilitation/complications; Artificial limbs; Health services accessibility; Health care costs; Cost of illness; Socioeconomic factors (*source: MeSH, NLM*).
Mots clés Traumatisme par explosion/rééducation et réadaptation/complication; Membre artificiel; Accessibilité service santé; Coût soins médicaux; Coût maladie; Facteur socioéconomique (*source: MeSH, INSERM*).
Palabras clave Traumatismos por explosión/rehabilitación/complicaciones; Miembros artificiales; Accesibilidad a los servicios de salud; Costos de la atención en salud; Costo de la enfermedad; Factores socioeconómicos (*fuente: DeCS, BIREME*).

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Voir page 669 le résumé en français. En la página 669 figura un resumen en español.

انظر صفحة 670 للاطلاع على الكلمات المفتاحية والملخص باللغة العربية

Background

Landmines and unexploded ordnance result in significant musculoskeletal injuries throughout the world. In every conflict since 1938 antipersonnel mines have been used extensively, often resulting in death or injury to non-combatants, and have accomplished only limited military objectives (*1*). In recent years, mines have been used increasingly as weapons of terror against local civilian populations in an attempt to isolate them or force them from their communities by depriving them of access to farmlands, roads, and even necessities such as drinking-water and firewood (*2*).

The antipersonnel mine is small and is set off either by a trip wire or a pressure switch that requires minimal pressure (typically 6 kg). It is designed to maim or kill anything that comes into contact with it, which often includes civilians, children and animals. Unfortunately, antipersonnel mines have a long life span: they can kill and maim indiscriminately for decades. Many mines remain from the Second World War; in addition, since the 1960s as many as 110 million mines have been spread throughout the world into an estimated 70 countries (Table 1) (*1, 3, 4*). In addition to antipersonnel mines, submunitions such as bomblets delivered by air or artillery, multipurpose weapons, and unexploded ordnance should be regarded as mines. These submunitions are often more difficult to identify and clear than mines. Landmines are unaffected by cease-fires or peace. The only way to deactivate them is by individual removal at a cost of US$ 300–1000 per mine (*5*). Even with training, mine disposal experts expect that for every 5000 mines cleared one worker will be killed and two workers will be injured by accidental explosions (*6*).

Modern technology has been able to make plastic mines that are smaller and less detectable. Mines cost between US$ 3 and US$ 75 to produce (*5*). Unfortunately, their small size, design and often colour make them very attractive to children, who may pick them up thinking they are toys. Remote delivery methods, such as dropping them by aircraft or artillery, has increased the random, unmapped dissemination of antipersonnel mines, primarily into rural areas where unsuspecting victims have no idea they are there (*7*).

The longevity of the mines and their random dispersal into rural areas make it difficult to know the true extent of the global landmine hazard. What is known, but is not quantifiable, is the human suffering that they engender. An estimated 800 people die monthly from landmine-related injuries (*2, 5*), and 15 000–25 000 people a year are maimed or killed by landmines (*7*); approximately 80% of these casualties are civilian (*8*). The actual numbers may be higher, given that many incidents occur in remote areas without medical facilities to document them.

Children are more likely to die from landmine injuries than adults, because their smaller size means that their vital organs are closer to the blast of a detonating mine (*2, 9*). Children are also less able to survive substantial blood loss than adults. It is estimated that 50% of victims die within hours of the blast, many of them never reaching medical care that may be hours away on the back of a camel or over bumpy roads in a truck (*10, 11*). This large incidence of prehospital mortality suggests fatalities from landmines and unexploded ordnance several times higher than published data from hospitals and the International Committee of the Red Cross (ICRC). For 25% of victims, hospital care is up to six hours away; and 15% of victims must travel for more

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Table 1. **World distribution of landmines**[a]

Country or area	Estimated no. of landmines (x10^6)
Afghanistan	10
Angola	10
Bosnia	6
Cambodia	7
China	10
Croatia	3
Ecuador	0.06
Egypt	23
Eritrea	1
Honduras	0.03
Iran (Islamic Republic of)	16
Iraq	10
Kuwait	5
Mozambique	3
Nicaragua	0.108
Somalia	1
Sudan	1
Ukraine	1
Viet Nam	3.5
Western Sahara	4
Zimbabwe	2

[a]Sources: ref. *2, 3, 5, 7–9, 26.*

than three days to reach the hospital. The mortality for individuals with landmine injuries has been shown to decrease by 50% with an effective medical infrastructure, adequate first aid, and available medical resources (*12*). The blast and fragmentation injuries from landmines result in wounds containing dirt, debris, pieces of the mine and bone fragments. Surgery is difficult, as the wounds are often ragged and each piece of foreign material must be removed or infection will ensue (*13–15*). In developing countries the average hospital stay for a patient with a bullet wound is 18 days, and treatment requires an average of 1.9 operations and 0.5 units of blood. In contrast, a patient with a mine injury requires an average hospital stay of 32 days, 4 operations, and 3.2 units of blood (Table 2) (*16*). Victims who survive the blast may have injuries to lower extremities, genitals, arms, chest, face and eyes, as well as suffering the psychological trauma of the incident and their injuries. More than one-third of survivors require amputation (*5*), though the incidence of amputation varies according to the type of mine.

Rehabilitation consequences of landmine injuries

Overwhelmingly, the victims of landmines and unexploded ordnance come from areas and countries where access to basic medical care is limited. Most often, the medical infrastructure is rudimentary and trained personnel are scarce.

Table 2. **Average figures per patient for ICRC hospital stay, by wounding agent**[a]

Wounding agent	Hospitalization (days)	No. of operations performed	Units of blood used
Bullet	18.1	1.9	0.5
Fragments	13.7	2.1	0.5
Buried mine	32.3	4.0	3.2

[a] Sources: *10, 16.*

Developing, war-torn countries — with damaged infrastructures at government and community levels — lack systems for rehabilitation service delivery, trained rehabilitation professionals, financial and technical resources and a vocational rehabilitation system. Other obstacles to rehabilitation include architectural barriers, lack of sanitation, other priorities for primary health care, high unemployment and a low societal awareness of disabled people's capabilities.

WHO reports that almost all developing countries have some rehabilitation services, but that such services generally reach less than 5% of the people with disabilities in the community. These services are frequently based in hospitals in centralized urban areas, which results in prohibitive costs and limited accessibility for the general population. In response, WHO recommended the integration of rehabilitation services into community-based primary health care systems (*17*).

Pre-prosthetic rehabilitation

During the pre-prosthetic phase of rehabilitation of the landmine victim with a lower extremity amputation, retaining as much function as possible is of prime importance. Full active or passive range of motion of all limbs is necessary to prevent joint contractures, which can make fitting and wearing a prosthetic limb difficult or impossible. Isometric exercises and progressive resistive exercises should be done on all limbs to maintain and strengthen muscles necessary for the rehabilitation process, crutch walking, ambulation, and a prosthetic limb. The patient should be ambulating on crutches as soon as possible to prevent deconditioning and the effects of prolonged bed-rest. As soon as the wounds are closed, the residual limb should be wrapped with elastic bandages and elevated.

Instruction on bed mobility, standing pivot transfers, self-care and crutch ambulation should be started as soon as possible. During the pre-prosthetic time, the amputee needs to increase residual limb care strength, cardiovascular endurance and balance on a single limb.

Prosthetic rehabilitation

The prosthetic phase of amputation rehabilitation focuses on fitting the prosthesis and on gait training activities. The fit is essential, as comfort will help to determine the acceptance of the limb by the patient as well as the resulting function. For the patient, the use of a prosthetic lower limb eliminates the need for crutches and frees the individual's hands for tasks of everyday living. A lower limb prosthesis is made of three basic components: the *socket* to fit the residual limb

of the individual (patient prosthetic interface), the *pylon/knee joint* which replaces the length of the lost limb (incorporates a knee joint if the amputation is above the knee), and the *foot*. The patient then advances to a stage in which residual limb and pain control are stable. The amputee may progress to independence in mobility, transfers, self-care, and ambulation using the prosthesis over time.

ICRC sponsors limb-fitting centres throughout the world in countries affected by mines. Up to 1989, ICRC made maximum use of local and variable materials for the production of prosthetic limbs. Because of technological developments since then, all components of an artificial limb are now made from polypropylene (a thermoplastic). The advantages of the ICRC prosthetic limb are that it gives the amputee a light, individually fitted artificial limb, which is cheap and can readily be repaired or replaced. The material is also easy to transport and to work with: it can be recycled, and there is no waste. ICRC trains local technicians in the use of this technology, and many mine amputees find employment in the limb-fitting centres. The intent of these programmes is to ensure that the centres continue after ICRC transfers responsibility to a partner organization or a governmental body in the country concerned. Since 1979, over 65 ICRC rehabilitation projects in 25 countries have manufactured more than 180 000 artificial limbs for 160 000 amputees. In addition, 235 000 pairs of crutches and 14 000 wheelchairs have been made (Table 3) (*18*).

The medical costs of treatment, physical rehabilitation, and prosthetics to treat individuals with landmine amputations vary from country to country. Factors that contribute to the costs include the importation of all materials, the need to use expatriate workers, and the need to transport personnel and materials by air. ICRC reports that all expenses are higher in the initial phase. Hospitalization costs are approximately US$ 120 per patient per day. This includes transportation costs, but not the salaries of expatriate staff. The total charge in an ICRC hospital is approximately US$ 3000–4000 for a patient suffering from an injury caused by a landmine (*2, 18*).

The costs of a prosthetic limb vary between US$ 125 and US$ 1875 (*2*). In Colombia, the ICRC technical assistance programme for the national rehabilitation centre (CIREC) produces transtubular prostheses for below-knee amputation at approximately US$ 212 each. In Viet Nam from 1989 to 1995, the Ho Chi Minh City rehabilitation centre produced prostheses for nearly 5000 amputees with manufacturing costs of US$ 38–64 per prosthesis. Individuals usually require a new limb every two years, so ICRC calculates the average total cost of fitting one person to be about US$ 1000; it would take most victims a decade or more to earn this amount. An adult typically requires the prosthesis to be replaced every 3–5 years, and a child with a lower limb amputation could be expected to need 15–20 artificial limbs in a lifetime (*2, 5*). Crutches are a much more likely outcome for an individual with lower extremity amputation.

Impediments to adequate treatment

There are multiple barriers to the treatment of patients suffering from landmine injuries, which combine to exclude individuals from appropriate rehabilitation. The US State Department estimated that only one-quarter of patients with amputations secondary to landmines and unexploded ordinance receive appropriate care (*19*). The following

Table 3. **ICRC physical rehabilitation programmes: production statistics for 2001**[a]

Countries	No. first-time patients (prosthetics)	No. prostheses[b]	No. prosthesis for mine victims	No. first-time patients (orthotics)	No. orthoses[b]	No. crutches	No. wheelchairs
Afghanistan	1 176	3 985	3 029	3 536	6 305	5 713	731
Angola	1 067	1 953	1 578	20	28	3 454	106
Azerbaijan	130	292	47	269	545	112	3
Cambodia	330	1 080	1 024	327	617	2 073	166
D.R. Congo	125	236	67	13	22	463	0
Ethiopia	698	1 902	726	1 061	1 498	2 505	54
Georgia	208	473	97	213	612	344	28
Iraq	964	2 301	1 168	488	814	518	5
Kenya	128	365	91	112	174	718	23
Myanmar	1 595	2 139	1 539	63	95	88	0
Sri Lanka	84	257	130	18	47	46	36
Sudan	331	839	158	465	603	308	0
Tadjikistan	360	444	53	0	0	288	11
Uganda	222	235	72	137	163	7	0
Totals	**7 418**	**16 501**	**9 779**	**6 722**	**11 523**	**16 637**	**1 163**

[a] Source: ref. *18*.
[b] Including first-time patients.

factors (*1, 2, 4–6, 8–10, 15–17*) impact on treatment possibilities.

Access. Accessibility of urban medical centres is limited, as people are injured by mines over large geographical areas and are unable to be transported to receive medical care.

Protection. In some countries, combatants may prevent wounded people from travelling to disputed areas where hospitals are located. For example, ICRC rehabilitation centres had to be closed after being hit by rockets or when heavy fighting near them made working conditions too dangerous.

Security. Lack of security is a major problem in many of the areas in which mine injuries occur, and it is too dangerous for outside agencies to function. Examples include hospitals where ICRC personnel have been threatened, beaten and killed; facilities have been damaged, looted and destroyed.

Politics and administration. Constraints result in hindrance of the delivery of appropriate medical care by the combatant parties. Assistance to wounded people in one area may go against the desires of other parties to the conflict.

Poverty. In many war-torn areas the only individuals receiving adequate health care are those who can afford it. Other people either rely on aid agencies or go without treatment.

Education and social structure. Where there is a lack of social infrastructure and people with education, the cost and difficulty of delivering medical services rapidly escalates if it is dependent on expatriate personnel. Appropriate medical care depends upon trained individuals and appropriate facilities.

Funds. Assistance to mine victims is extremely expensive on a per person basis. Financial constraints occur in all agencies and in all programmes.

Coordination. The lack of interagency coordination results in a patchwork of services. Different agencies involved in rehabilitation care may give conflicting and confusing advice. Donated medical supplies and equipment could be inappropriate and unusable.

Interagency rivalry. Interagency rivalry leads to inadequate treatment of the target population. Unfortunately, some programmes are never evaluated as to necessity, integration with other programmes, or appropriateness for the target population.

Individual consequences

The individual with an injury due to landmines or unexploded ordnance may suffer initially any or all of the following: multiple fragmentation wounds, amputation of one or more extremities, and loss of senses (vision, hearing and touch). If this person survives the initial injury, then he or she may be faced with any or all of the following: loss of function, body disfiguration, chronic pain caused by the injury or the amputation, as well as post-traumatic stress disorder (recurrent memories of the injury and pain) (*11, 20–22*).

The success of individual rehabilitation depends heavily on how well the person reintegrates into society. Reintegration is partly dependent on the adequacy of the physical rehabilitation and partly on the patients and their support system. How disability is viewed and accommodated in the culture of the community will contribute to the individual, social, and economic consequences of landmine and unexploded ordnance injuries (*23*).

Social consequences

Unfortunately, little information exists on what happens to individuals suffering from amputation as a result of landmines over time; limited studies suggest, however, that injuries to the survivors have far-reaching effects (*24*). A study of the social costs of landmines in Afghanistan, Bosnia, Cambodia, and Mozambique revealed that 25–87% of households had their daily activities affected by landmines: 6% of households reported a landmine victim (*10*). Most landmine incidents occur in developing countries or regions where the victims are peasant farmers, herdsmen, nomads or fleeing refugees. Because of this, they rely primarily on their physical abilities for their basic subsistence. Many survivors never regain their ability to participate fully in family life or their society. In these cultures, each member of a family tends to play an important role in day-to-day survival of the group; the existence of the entire family may therefore be threatened by the injury of one member. One study indicated that households with a landmine victim were 40% more likely to have difficulty in providing food for the family (*10*), and concluded that the expense of medical care and rehabilitation add economic disability to the physical burden resulting from landmine injury. If the victim is a child, his/her whole future is at stake as he/she is likely to be dependent on others for the rest of his/her life. In some cases, landmine victims become beggars in order to survive.

Resources that are directed to care for victims of landmines are not available for other public health measures such as vaccination, sanitation, safe water supply, nutrition and vector control. The wide dispersal of landmines also impedes the delivery of international humanitarian supplies and endangers the lives of relief workers. The increased security measures needed to protect workers can considerably increase the cost of the aid. If land transport of workers and supplies is impossible because the roads are mined, the cost of air transport to an area can be 25 times higher (*2*).

Economic consequences

Landmines also have far-reaching implications, and one of the most obvious is that they make land uninhabitable. Throughout the world millions of acres of land are abandoned because they are mined. The dispersal of the mines in many cases is so random and scattered that even those who were responsible for their dissemination have no idea where they are. Coupled with the fact that mines are mostly used in rural areas where land is employed for farming or grazing as the primary means of livelihood, this puts a severe strain on people who live on natural resources that are often already marginal. The presence of mines in agricultural areas not only impacts on the local community which relies on the land for a living, but the decreased food production may have widespread consequences for the country or region as a whole (*2, 6*). Andersson suggested that, without mines, agricultural production could be increased by 88–200% in Afghanistan, 11% in Bosnia, 135% in Cambodia, and 3–6% in Mozambique (*10*). Landmines were seriously detrimental to the economy and food distribution in each of these countries. The societies with the most severe landmine problems are decimated by war and among the poorest in the world.

The presence of landmines in breeding areas of the desert locust (*Schistocerca gregaria*), armyworm (*Spodoptera exigua*), tsetse fly and mosquitoes makes control and eradication of these pests difficult, with the last two vectors increasing the risk of trypanosomiasis and malaria, respectively. The desert locust poses a particularly startling threat to crops if allowed to breed to plague proportions, because the insects can cover 150–200 km a day, eating their weight in food. Such a plague could take 4–5 years to contain and jeopardize the food supply of 10% of the world's population (*2, 25*).

Postwar economic recovery suffers under the burden of amputees who often can no longer support themselves or their families. Frequently, refugees are unable to return home because their land has been mined. Many of these people become permanent refugees, which places a severe economic and social strain on the community and country that took them in (*7*). The promotion of tourism as a boost to the local postwar economy can be severely hampered by the presence of landmines.

Prevention and education

Because it is unlikely that mined areas can or will be cleared in the near future, public health injury prevention programmes are a means of reducing the number of deaths and injuries caused by mines. Mine awareness programmes teach local populations to avoid areas that are known or suspected minefields, to recognize landmines, and what to do if one is found (26). Some reports suggest, however, that these programmes are expensive and ineffective (*27, 28*).

ICRC has developed video and teaching material about the surgical treatment of landmine victims. A surgical seminar dealing with landmine injuries is held every year in Geneva for medical personnel from Red Cross, Red Crescent, and other organizations. In addition, ICRC provides extensive training for personnel in trauma hospital administration.

The Ottawa Convention (Convention on the Prohibition of the Use, Stockpiling, Production and Transfer of Antipersonnel Mines and their Destruction) became effective on 1 March 1999. The Mine Ban Treaty calls upon all states to cease the use, transfer and production of antipersonnel mines. It has stigmatized the use of antipersonnel landmines as a weapon of war because of their indiscriminate nature. The export of landmines has ceased, stockpiles have been destroyed, and their production has decreased. As of 2003, a total of 130 countries had signed the Convention and 122 had ratified it (*29*).

Landmines and unexploded ordnance continue to be a huge international problem with long-term individual, social, and economic consequences. There are many impediments to both acute wound treatment and long-term rehabilitation of the victims. ■

Conflicts of interest: none declared.

Résumé

Victimes des mines terrestres – Difficulté de la réadaptation

Souvent utilisées aveuglément, les mines antipersonnel font fréquemment des victimes dans la population civile. Depuis 65 ans, plus de 110 millions de mines ont été répandues dans un nombre de pays estimé à 70. Les soins aux victimes de mines terrestres absorbent une quantité démesurée de ressources médicales ; l'immense majorité des accidents surviennent dans des régions et des pays qui ne disposent pas d'infrastructures médicales modernes et où les ressources sont limitées, ce qui rend la réadaptation difficile dans le meilleur des cas. Le quart seulement des personnes ayant subi une amputation consécutive à l'explosion d'une mine terrestre bénéficierait de soins appropriés.

Resumen

Rehabilitación de las víctimas de las minas terrestres - el gran reto

Las minas terrestres antipersonal se suelen usar indiscriminadamente y causan con frecuencia lesiones o muertes entre la población civil. En los últimos 65 años se han dispersado más de 110 millones de minas en unos 70 países. Las víctimas de las minas terrestres absorben una cantidad desproporcionadamente alta de recursos médicos; la gran mayoría de los accidentes se dan en regiones y países que carecen de una infraestructura médica avanzada y de recursos suficientes, y donde la rehabilitación es difícil en el mejor de los casos. Se ha señalado que sólo una cuarta parte de los pacientes con amputaciones debidas a minas terrestres reciben la atención necesaria.

ملخص

تأهيل ضحايا الألغام الأرضية – التحدي الأخير

عادة ما تستخدم الألغام الأرضية المضادة للأفراد دون تمييز، وكثيراً ما ينجم عنها إصابة أو وفاة أشخاص غير محاربين. وفي السنوات الستين الأخيرة تم نشر ما يزيد على 110 مليون لغم في العالم في نحو 70 بلداً. ويستهلك ضحايا الألغام الأرضية كميات كبيرة وبشكل غير متناسب من الموارد الطبية؛ وتحدث الغالبية العظمى من حوادث انفجار هذه الألغام في مناطق أو بلدان تفتقر إلى البنية الأساسية الطبية المتقدمة وإلى الموارد الكافية، مما يجعل تأهيل الضحايا مهمة صعبة في أفضل الظروف. وتشير الدراسة إلى أن ربع المرضى المصابين ببتر ناجم عن الألغام الأرضية هم فقط الذين يحصلون على الرعاية المناسبة.

الكلمات المفتاحية: الانفجارات، الإصابات/التأهيل/المضاعفات؛ الأطراف الاصطناعية؛ الحصول على الخدمات الصحية؛ تكاليف الرعاية الصحية؛ تكاليف المرض؛ العوامل الاجتماعية الاقتصادية.
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