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MANAGING TECHNOLOGY TRANSFER MODEL FOR THE REHABILITATION SUPPORT IN MINEFIELD CASUALTIES

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ABSTRACT
This paper describes the use of rapid prototyping technology for the production of lower limb prostheses and a model of modern technology transfer to Bosnia and Herzegovina - BiH. This country was identified as one of 24 States Parties with significant numbers of mine survivors, and with "the greatest responsibility to act, but also the greatest needs and expectations for assistance" in providing adequate assistance for the care, rehabilitation and reintegration of survivors.
Keywords: technology transfer, rapid prototyping, prostheses

1. INTRODUCTION
Numerous areas around the world and particularly those at south east of Europe (Croatia and Bosnia mostly) were contaminated with landmines, following the conflict between armed local forces. Consequently, UN Security Council established Trust Fund for Demining and Mine Victims Assistance Program, which has made a crucial contribution to re-establish a secure environment in the contaminated areas and helping the rehabilitation of landmine casualties. In these program Slovenia is one of the most active countries in the sense of supporting demining activities and helping in rehabilitation of the injured victims. Slovenian Institute for Rehabilitation with its Center for the Rehabilitation of Mine Victims (SIR - CRMV) has been established to assist with placement of the victims, logistics, medical rehabilitation, production and application of orthopedic and technical aids and education and training the experts. Today, a CAD-CAM system is a technology already used for designing and manufacturing of prosthesis sockets. It uses the advantage features of modern computer technology (laser scanner, appropriate software and milling machine) to help prosthetist to make a perfect prosthetic socket. Presented results give latest technology essential advantages such as: shorter production time, high quality and user-friendly applications. The knowledge and experience gathered through the production of prostheses are the opportunity for a successful transfer and long-term co-operation. The model of transfer of the latest technology and knowledge represents preparation and production functioning as an organizational mechanism, which will be capable of accepting the changes in the environment and to satisfy the users/patients needs as well.

2. PROSTHETICS PROBLEM
For 2003, Landmine Monitor identified over 8,065 new casualties, of which 23 percent were children, in 65 countries. Compared to last year's Landmine Monitor Report, there were four new countries with reported casualties from mine-related incidents: Armenia, Bolivia, Cyprus, and Liberia. Landmine Monitor has identified more than 230,000 mine survivors recorded in 97 countries and nine

areas; some are from incidents dating back to the end of the World War II, but the vast majority of survivors are from the mid-1970s onwards. Given the high number of casualties that likely have never been recorded, it is reasonable to assume that there are somewhere between 300,000 and 400,000 mine survivors in the world today [1].

Improvements in prosthetics and other assistive devices has to be attributed to the research and development in prosthetics over the last two decades and has been focused on developing artificial limbs for amputees in affluent, industrialized countries. New lightweight materials, including plastics, together with electronic and other technological advances, have transformed the lives of amputees in these countries. Unfortunately, the standard prosthetic technology used in industrialized countries today cannot be financed by either developing countries or international relief organizations in sufficient quantity, functionality and quality to meet needs. Similarly, many other resources that were developed specifically to improve service provision in high-income countries cannot be directly transferred to low-income countries without being adapted to accommodate for differences in language, culture, climate and local infrastructure [2].

Harte has described five stages to prosthetics/orthotics (P&O) and rehabilitation programs in the war-affected countries where land mine survivors live:

- Conflict: heavy reliance on expatriate expertise and labor, and rehabilitation services are considered a low priority.
- Post conflict: rehabilitation personnel have emigrated or are demoralized and are emerging from war-induced professional isolation. Infrastructure to serve the disabled population is badly damaged - multiple NGOs operate, often with little coordination.
- Recovery: service provision, established in the conflict and post-conflict stages generally continues to be managed by the International Committee of Red Cross (ICRC) and NGOs. Providers predominantly employ expatriate professionals who engage in some variations on the Jaipur limb systems allow for local component manufacturing.
- Development: structured P&O training programs are established to international standards. Investments and external funding now focuses on developing local or government managed hospitals and P&O facilities. International prosthetic component manufacturing companies begin to market heavily to ministries of health. Interagency cooperation and the coordination of services increase. Issues related to management and corruption become more acute.
- Sustained program activity: International investment in infrastructure and service provision is scaled back. Programs are cut as they learn to survive on local or regional funding. P&O and rehabilitation services are nationalized, increasing integration with other sectors of the health care system, and training moves from other producton facilites to regional training programs.

Since 1996, the ICRC and the BiH Red Cross network throughout the country have collected mine casualty data and provided up-to-date information on landmine and unexploded ordnance (UXO) incidents. As of 1 July 2005, the ICRC/RCS database contained information on 4,878 mine/UXO casualties (959 people killed and 3,919 injured) since 1992. ICRC records indicate that mine/UXO casualties in BiH have declined each year since 2000.

In BiH, there are 13 public orthopedic workshops and 14 private workshops. The standards of facilities and quality of care are said to vary dramatically across BiH. There are between 60 and 70 orthopedic technicians in BiH, but very few have received training to an international standard. There is no official recognition of the profession in BiH [3]. The high cost of prostheses and other assistive devices is said to limit the government's ability to meet the needs of mine survivors and other amputees. Civilian mine survivors must pay for their healthcare or insurance. They receive much lower and more irregular compensation for their injuries than military survivors. In some cases, civilians must pay a part of their medical costs and a portion of the costs of their prostheses, which can be prohibitive for many in a country where the average wage is around $880 per year [4]. In BiH, through the Ministry of War Veterans, a military mine survivor has the right to a free prosthesis every third year, free healthcare and insurance, free treatment in special rehabilitation centers, and compensation for a disability. However, the government reportedly has difficulty balancing needs with available resources. In June 2004, a new Law on War Veterans was approved.

3. TECHNOLOGY TRANSFER MODEL

Criteria for successful technology transfer:

- Communication: passive communication is cheaper, but it doesn't guarantee the receiver was acquainted; interactive channels have to be adopted, basing on personal contacts that are faster, we get feed-back, they assure more implementation and commercialization possibilities [5].
- Distance: or remoteness can be physical or cultural [5]. A mix of organization's and local environment's culture is needed for successful knowledge and technology transfer.
- Unequivocality: more the knowledge and technologies are sophisticated; more difficult they are to transfer. We have to avoid misleading the customer with adequate technology for use, if suitable technology doesn't allow easy transfer [6].
- Motivation: it includes stimulation and realization of knowledge and technology transfer importance. Personal motivation in active cooperation within the process of transfer can vary from affection to hostile opposition. Closer we are to the level of commercialization in the knowledge and technology transfer; bigger is personal motivation [7].

Weaknesses of old technology, using wood, plaster and craftsmanship are predominantly: longer production time, small machines effectiveness, high costs per unit because of manual work, lack of connection between working positions, accurateness of production documentation, improvisation isn't longed, but sometimes necessary, high stocking costs because of uneven consumption. Some strengths: different products can be made on same working posts, equipment is universal, investing costs in basic equipment are lower because of universal machines use.

Basic idea for the latest technology, used in prosthetic production and application was born in 60-ies; first system was presented on the 4-th ISPO (International Society for Prosthetics and Orthotics) congress in 1983. Since then CAD/CAM (Computer Aided Design – Computer Aided Manufacture) development blossomed. Simplified process would comprise a computer program for data analysis, 3 dimensional model production, stored in a CAM form and transferred to CNC (Computer Numeric Control) supported lathe. In 90-ies technology achieved higher level, machines got smaller, lighter and transportable.

Latest technology prosthetic manufacturing working process differs from the very beginning. Basic materials as polyurethane blocks, prosthetic parts (plastic plates for layers, knees, junctions, and feet) are already stocked in smaller quantities. Steps follow like this:

- CAD laser measurement is performed,
- residual limb is three dimensionally scanned, and analyzed with computer,
- CAM data are transferred to CNC lathe and manufacturing process of positive model begins, made of hard polyurethane foam,
- manufactured item gets protected with hot plastic cover. After the piece is cooled down, it must be cut out and trimmed. Negative presents the patients residual limb,
- parts of prosthesis are attached to the layer,
- prosthesis gets statically settled and adjusted,
- test is done on patient; plastic layer allows warming and smaller adjustments, without destroying basic prosthesis structure, dynamic employment of layer, knee and foot is made,
- after successful testing, prosthesis can be finalized, team proved and applied on patient.

Latest technology strengths are: time saving, replication possibilities, quick adjustment process, possible afterwards changing of model, without new residual limb measurements, possible measurement of changed model forms, saving the shapes measurement, better working process overview, possible systems integration in combination with telecommunications aid (taking measures on one spot, CAM model production on another with information transferred online. Time saving is one of the most important advantages of latest technology implementation; it saves number of days, needed in postoperative hospital care and shortens the expedient application. Some weaknesses: possibility of additional corrections is limited, gradual learning path, especially for personnel that never used a computer, manual laser is very susceptible for magnetic interferences, high cost of purchase and introducing, which limits the number of patients.

Model of technology transfer began with the Rehabilitation institute of Republic of Slovenia and International Trust Fund – ITF, International foundation for demining and mine casualties' assistance decision, to build a Center for prosthetics and orthotics in Tuzla (BiH). Main goal was the technology and knowledge transfer in their environment. Latest technology transfer is an organized process; it demands a team formation, composed of two separated groups, one in Slovenia, one on the new location. On place education of labor force is planned in Slovenia, it assures successful transfer. Simultaneously with the technology transfer, parallel restore of production is planned; this should eliminate possible delays and oscillating between transfer. When complete organizational structure is set up and transferred all the equipment to the new location, production process begins, first as pilot and later regular production. After the introduction of regular production, team dissolves, but professional control is still to be performed; after one year and later as required [8].

Thanks to the model of transfer and construction of Center for prosthetics and orthotics in Tuzla, this area will have access to the latest technology in application of medical technical aid. Capacity is planned to be around 250 land mines casualties' rehabilitations. Funding for the technology transfer and Center construction is to be raised through donations, under the umbrella of ITF and USA, they multiply each dollar with another one.

4. CONCLUSION

Presented model is suitable to apply in any environment, where they don't dispose of knowledge and possibilities to produce and implement prosthesis, orthosis, crutches, invalid chairs and other medical aid. When using latest technologies, it is also assured kind medical and diagnostic reception, center lucrative functioning and its future existence, knowledge and professionalism of technical personnel and management. Model depends on partnership, personal contacts, win-win concept and cooperation, which enables both, the givers and receivers of knowledge and technologies lots of opportunities. Givers have the opportunity to build first level of inter-organizational system and increase the critical mass, connect with other environments, which fundamentally relieves problem solutions, to big and to complex for singular organization. Receivers are enabled to assure quality, increase capacity and connections with developed environments. It allows them to raise the economic development and capability to integrate into world economic and social trends. All this leads to the conclusion that proposed model of technology and knowledge transfer to low-income countries is realistic and manageable. Proposing a model like this leads to positive and favorable climate, also to include donors, which will be warmly accepted by this environment.

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