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No. 4, 1996

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CONTENTS

Königová, R.: Factors Influencing Survival and Quality of Life in Burns	116
Teich Alasia, S., Castagnoli, C., Calcagni, M., Stella, M.: The Influence of Progress in the Treatment of Severe Burns on the Quality of Life	119
Raff, T., Germann, G., Barthold, U.: Factors Influencing the Early Prediction of Outcome from Burns	122
Munster, A. M., Fauerbach, J. A., Lawrence, J.: Development and Utilization of a Psychometric Instrument for Measuring Quality of Life in Burn Patients, 1976 to 1996	128
Bortolani, A., Governa, M., Barisoni, D.: Fluid Replacement in Burned Patients	132
Colić, M., Ristić, L., Jovanović, M.: Emergency Treatment and Early Fluid Resuscitation Following Electrical Injuries	137
Raff, T., Hartmann, B., Wagner, H., Germann, G.: Experience with the Modified Meek Technique	142
Governa, M., Bortolani, A., Beghini, D., Barisoni, D.: Skin Expansion in Burn Sequelae: Results and Complications	147
Summaries (in Czech)	154
Instructions to Authors	157
Contents Vol. 38, 1996	158
Index 1996	159

SCOPE AND LIMITATIONS

Acta Chirurgiae Plasticae is an international journal with a long-standing tradition respected by the professional public worldwide. It is published in English four times per year. The journal contains clinical, experimental and theoretic studies from the discipline of plastic, reconstructive and aesthetic surgery, surgery of the hand, craniofacial surgery, treatment of burns and allied surgical disciplines (traumatology, orthopaedics, gynaecology etc.). In the journal you will also find reviews, case-histories, innovations, comments, reports from study trips and congresses, reviews of books and various announcements.

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CONFERENCE OF THE CZECH BURN SOCIETY WITH INTERNATIONAL PARTICIPATION

Prague, Czech Republic

September 17 - 19, 1996

„QUALITY OF LIFE IN SEVERE BURNS“

The Conference mentioned above was organized by the Czech Medical Association J. E. Purkyně and by the Czech Burn Society together with the Prague Burn Center under the auspices of the Dean of the 3rd Medical School, Charles University - Prof. Cyril Höschl, M. D., DSc. and under the auspices of the Director of the University Hospital Královské Vinohrady - Zuzana Roithová, M. D.

The attendance at the Conference was represented by 131 members of burn teams from 19 countries - including Europe, United States and Iberolatinoamerican area.

Apart from 8 sessions dealing with multidisciplinary topics presented by specialists - scientists and clinicians, physiotherapists and social workers - there was held a parallel session organized by nurses. All aspects of burn care regarding nursing throughout the long-term treatment were conveyed in 18 communications.

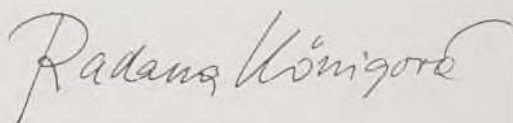
Various up-to-date products, medicaments and information materials were displayed in the Exhibition area by 13 firms and companies.

This Conference had been planned as a result of ties established through meetings and correspondence among those interested in the relationship between science and ethics.

The first goal of the Conference was to point out that the aim of burn care is to ensure survival of the burn patient, but survival is not a subtle enough indicator of the pathophysiological process or a measure of our success or failure. We must step back to the scar result and the psychological response of the patients to their scars. Scar disfigurement is the most important and decisive factor influencing the quality of life, though it might be affected by multiple subjective or/and objective factors in a positive or negative way.

The second goal of the Conference was to stimulate awareness of ethical problems now raised and of possible legal consequences. With the development of bio-sciences and their application to patients, the sum of all individual requirements in Medicine today has become much higher than society can provide, which is related to the ethical principles of autonomy and distributive (social) justice.

*Prof. Radana Königová, M. D., CSc.
Conference Chairman*



FACTORS INFLUENCING SURVIVAL AND QUALITY OF LIFE IN BURNS

Radana Königová

Prague Burn Center, Charles University Hospital, Prague, Czech Republic

SUMMARY

Among factors influencing the improved survival of burn patients belongs appropriate organization of burn care with the concentration of seriously burned patients at specialized centers, disseminating guidelines for assessing initial care, triage and transfer and providing multidisciplinary treatment using newly developed technology. Any unprofessional and unpropitious procedure in resuscitation (ventilation, circulation) or intensive care (surgery, nutrition, infection) may deteriorate the shortterm outcome. Efficacy of „accompaniment“ has been proved in the acute period as well as during the rehabilitation and reconstruction period, when the scar-formation is decisive for the quality of life. Development and maturation of scars is influenced by individual differences, racial differences and psychic condition. There has to be taken into account the physiological status of each single patient. Among factors influencing long-term outcome and quality of life belong age and underlying diseases as well as family and society-cultural background. Patients might well adjust to lower levels of health by sustaining their satisfaction with life. Those who have recovered from critical injury may experience even an increase in life satisfaction, though quality of life may appear diminished.

ZUSAMMENFASSUNG

Faktoren, die das Überleben und die Qualität des weiteren Lebens bei Verbrennungsverletzung beeinflussen

R. Königová

Ein wichtiger Faktor, der Einfluss auf das höhere Prozent der überlebenden Patienten hat, ist die Organisation der Pflege um die Verbrannten. Die Schwerbeschädigten gehören in die spezialisierte Zentren. Diese Zentren bestimmen Richtlinien für die unausschiebbare Behandlung, die Klassifikation, den Transport und sichern die multidisziplinäre Behandlung mit Verwendung der modernsten Technik. Jeder nichtfachgemässe oder ungelegene Eingriff im Laufe der Resus-zitation (die Ventilation, die Zirkulation) oder Intensivpflege (chirurgische Eingriffe, die Ernährung, die Infektion) können frühzeitig die Ergebnisse verschlechtern.

Die Bedeutung von der „Begleitung“ für das Überleben des Verbrannten wurde bewiesen sowohl in der akuten Phase, als auch in der Phase der Rehabilitation und Rekonstruktion, wann die Bildung und Reifung der Narben für seine Lebensqualität entscheidend ist. Die Bildung und Reifung der Narben wird von individuellen und rassigen Unterschieden und von psychischem Zustand des Patienten beeinflusst.

Es ist nötig den gesamten physiologischen Zustand jedes Patienten zu erwägen. Unter die Faktoren, die die langzeitige Ergebnisse und die Lebensqualität beeinflussen, gehören Alter, begleitende Erkrankungen, die Familie und sozial - kultureller Hintergrund. Die Patienten passen sich besser an die verschlechterte Gesundheitssituation an, wenn sie eine bestimmte Befriedigung oder einen bestimmten Sinn des Lebens für sich behalten. Diejenigen, die die kritische Verletzung überwinden, können sogar eine grössere Lebensfreude empfinden, obwohl ihre Lebensqualität herabgesetzt zu sein scheint.

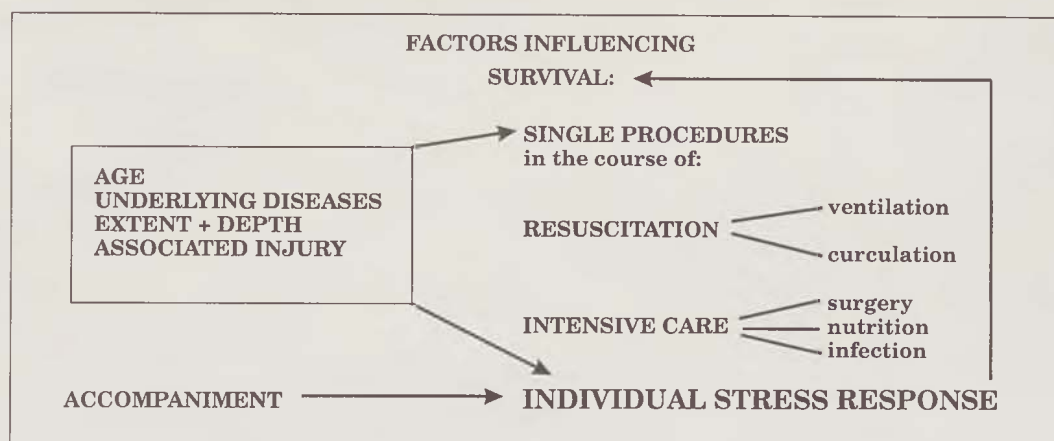
Key words: survival prediction, quality of life in burns, accompanying kin in burns, individual stress response in burns, scar formation in burns, dysmorphobia, eubiosia

To introduce this reflexion there should be remembered three meetings that took place in Prague this year.

The first one was organized in February by the Institute for Human Studies in Medicine of the 1st Medical Faculty, Charles University and by the Hastings Center, New York. It was focused on „Informed Consent and Doctor-Patient Relationship“. The second meeting was in June - the

8th European Congress of the FEAMC (European Federation of Catholic Medical Associations) under the auspices of the Archbishop of Prague, discussing the topic „Medicine today and our Image of Man“. The third meeting - also in June - was prepared by the Czech Medical Association J.E.P. in cooperation with the Association des Médecins francophones tchèques and with the Association Internationale Droit, Ethique et Science. This

Table 1.



Colloque Medical Franco-tchèque was dealing with a similar topic „La santé dans la société contemporaine“.

Prof. C. Huriet (le membre du Comité consultatif national d'éthique) from Paris pointed out that in the health care there are running three revolutions: medical, scientific and médiatique - in the informatory field. The medical revolution affects the therapy, diagnostic procedures and technology. The scientific revolution insinuates upon genetics and molecular biology. The revolution in the informatory field which means all the dissipating knowledge gave origin to social, economical, psychological and ethical problems.

The „apparatus-based“ medicine both fascinates and repels us, causing anxiety (1). It is linked in to burn care system at specialized centers. Fiona Wood wrote in the James Laing Memorial Essay (2) that historically has been demonstrated that burn patients have a better outcome if treated in dedicated burn-care facilities. Burn centres are authorized to provide guidelines for assessing care, triage and transfer taking advantage of multidisciplinary team approach and technological equipment (Table 1). Among factors influencing **survival** - short-term (intermediate) outcome - belong all single procedures in the course of resuscitation concerning ventilation and circulation and in the course of prolonged intensive care concerning repeated multiple surgery, nutrition and infection prophylaxis and therapy. This medical development has changed the doctor-patient relationship, some refer to it as a „wordless“ medicine. One of the important factors implicated in those influencing survival is **individual stress response**. We are well aware of the somatopsychic character of burn trauma, which may put the life of burn patient in jeopardy, the individual stress response and an inadequate response to therapy - playing the role of the lethal factor (3).

Cases have been recorded with relatively favourable prognosis deceased of psychic „hypothalamic“ death, due to protracted emotional stress, and failure of the limbic system.

On the other hand, cases have been documented of burn patients who survived a critical burn injury and recovered although the somatic prognosis according to the prediction rules seemed to be hopeless. Their survival and recovery was possible only thanks to **internal defence mechanisms** encouraged by the **accompanying kin**. Some authors (4) point to the importance of parental visits to successful adaptation and to the „survival phenomenon“, but according to our practice these visits in children may result in increasing anxiety corresponding with parent's periodic separations from the patient. This experience made us decide in favour of „rooming in“ not only parents or grand-parents in **pediatric burns**, but also in adults accompaniment may play the role of vital factor.

We admit wives (not so much husbands), sisters, brothers and adult children to the elderly. Since August 1980 till August 1996 there were „roomed in“ 541 accompanying persons. They have been selected in advance by the clinical psychologist, permanent member of our burn team. Accompaniment is rather difficult and conflicting task demanding special qualities and frame of mind. Our practice has revealed that burn injury might trigger psychosyndromes not only in patients but also in relatives, and therefore, the extraverts without any signs of reactive depression should be selected.

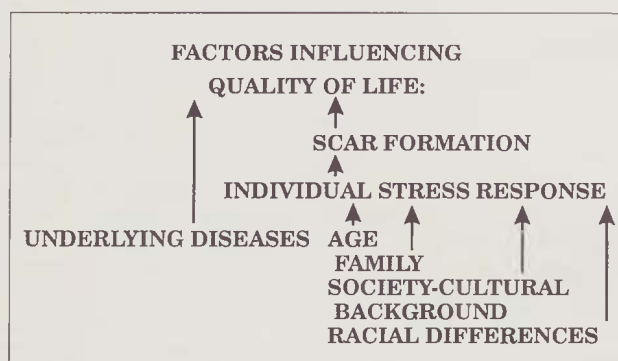
The long-term treatment in burns influences quality of life not only of the patient but also of the whole family. The crucial factor in the short-term outcome as well as in the long-term outcome is the patient's **age**. In the youngest and in the oldest age category in burns there is not only life at stake, but also quality of life, depending upon **scar formation and upon underlying diseases**.

The scar formation process is also related to the **individual stress response** which is remarkable in children and young patients.

The individual stress response may be modified by the family and society-cultural background. Permanent sequela scar disfigurement -

represents a chronic trauma influencing the quality of life in a more insidious often more malignant and permanent manner. The term **DYS-MORPHOBIA** (5) meaning the belief that some part of the body is ugly or unpleasant, fits many adolescent ideas. Under the influence of advertising, people have developed a strong interest in their bodies - especially in the western world - and therefore, the rehabilitation and readjustment must be guided by very wide cultural norms (Table 2).

Table 2.

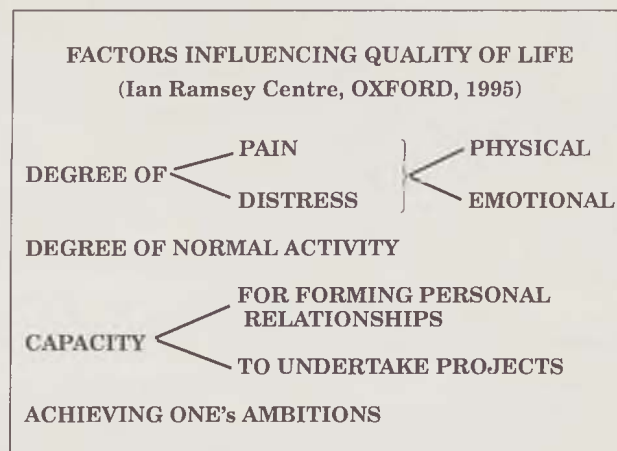


Among factors influencing not only survival but also quality of life belong also **underlying diseases**, which prevail in elderly. Old persons made by the injury completely dependent on others in all their functions - often with a justified feeling of helplessness, dismay and despair - bring us to the paradox that in those cases more sophisticated medical knowledge and practice may actually contribute to suffering. We help - in fact - to prolong life even in conditions when life's further sustenance has ceased to be a categorical imperative. At first sight, one is tempted to see nothing but non-sense in suffering, and nothing but extraneous and extraordinary non-sense in death (6). However, the doctor must try to relieve suffering and he must struggle against the death and he must do it with grace, wisdom and charity. The method of **EUBIOSIA** - high quality of life until the death was established by Franco Pan-nuti (7) in the 80's.

It offers medical and spiritual help in cases when any curative therapy has been stopped. It is re-developing in European countries as modern but traditional discipline - **PALLIATIVE CARE**. The spreading of the idea of palliative medicine is mainly supported by physicians interested in different values in a society suffering from money-focused materialism. Discussions in the Ian Ram-

sey Centre in Oxford (8) produced the following lists enabling to judge and measure „Quality of Life“ (Table 3).

Table 3.



In conclusion, let us remember that the meaning a patient can give to his suffering may only come from himself. He may discover that it can be a source of enrichment for himself. Patients might well adjust to lower levels of health by sustaining their satisfaction with life.

Those who have recovered from critical injury may experience even an increase in life satisfaction, though quality of life may appear diminished.

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THE INFLUENCE OF PROGRESS IN THE TREATMENT OF SEVERE BURNS ON THE QUALITY OF LIFE

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SUMMARY

The problems related to burns treatment can be considered among the oldest and most passionating in history of medicine. Since the early forties amazing progresses have been done in the comprehension of the physiopathology of burns. The fast development of resuscitating techniques determined a remarkable reduction of mortality in the first phase; in a similar way through new concepts in the project and construction of intensive care facilities dedicated to burns, where patients can be isolated and a high standard of environmental control can be guaranteed, together with new topical and systemic antibacterial treatment protocols, a significant reduction of infectious complications has been achieved.

Concerning surgical treatment early tangential excision and cultured epidermal grafts can be considered the cornerstones of burn therapy. Quality of life of burnt patients have been greatly ameliorated by these technical advances. Burn sequelae however remain the main concern of survivors because of the many controversial aspects of burn scar physiopathology and treatment.

Along my career many endeavours I dedicated in this important research field. I will then report the results of most interesting clinical and experimental studies carried out in the last 30 years by our group in collaboration with basic researchers.

All the work done in this domain enhance our hope that good results can really improve quality of life in burns: this is the goal for those who dedicated the whole life to relieve the suffering of these badly injured patients.

ZUSAMMENFASSUNG

Der Einfluss des Fortschrittes auf die Qualität des Lebens bei schweren Verbrennungen

S. Teich Alasia, C. Castagnoli, M. Calcagni, M. Stella

Probleme, die sich mit der Verbrennungsbehandlung befassen, können zu den ältesten und schwersten in der Geschichte der Medizin eingereiht werden. Seit Anfang der 40-er Jahre begann ein beachtenswerter Fortschritt auf dem Gebiet der Pathologie. Die schnelle Entwicklung der Resuszipationstechnik brachte eine erhebliche Herabsetzung der Mortalität in der ersten Phase. Die Infektionskomplikationen wurden bedeuten reduziert sowohl durch neue lokale und gesamte Mittel in der antibakteriellen Behandlung, als auch durch eine neue Konzeption der Stationen zur Behandlung der Verbrannten. In diesen sind die Patienten isoliert und gleichzeitig wird eine gradige Kontrolle ihre Umgebung erreicht.

In der chirurgischen Behandlung kann die rechtzeitige Tangenzexision und Kultivation der epidermalen Lappen als ein Fortschritt in der Verbrennungstherapie angesehen werden. Die Lebensqualität der verbrannten Patienten ist durch diese technische Fortschritte bedeutend verbessert. Die Verbrennungsfolgen bleiben jedoch im Mittelpunkt des Interesses bei den überlebenden Patienten wegen der Unterschiedlichkeit in den Ansichten auf die Pathophysiologie und Narbenbehandlung.

Mein ganzes gesamtes fachärztliches Leben widmete ich diesem Forschungsbereich. Ich möchte im folgenden die Ergebnisse aller interessanten klinischen und experimentellen Studien beschreiben, die in den letzten 30 Jahren von unserer Gruppe in Zusammenarbeit mit der Grundforschung ermittelt wurden. Alle Arbeiten auf diesem Gebiet erhöhen unsere Hoffnung, dass die guten Ergebnisse wirklich die Lebensqualität verbessern können. Dies ist das Ziel derjenigen, die ihr ganzes Leben dem Mitleiden des Leidens dieser schwerverletzten Patienten widmeten.

Key words: progress in burn care, hypertrophic scars, burns, quality of life

The problems arising from the treatment of burns are amongst the oldest and most fascinating in the history of medicine.

However, it was only at the beginning of the second World War that we started studying the physiopathology of burns and that the effects of

extensive thermal injuries upon the body became better understood.

The rapid progress in resuscitation techniques (Baxter, 1970) achieved a dramatic reduction of early mortality rates but we still had to deal with the high risk of wound infection (Pruitt,

1992) the primary cause of the systemic infections we dread.

To reduce the risk of infection, special care units for the treatment of extensive burns, where patients could be isolated in a controlled environment, were built in the first decade after the War (Muir, 1962). In these units, a small number of which were built both in Europe and in the United States in the forties and fifties, the open treatment was the rule. It was the first major improvement in the management of people who had suffered burns. Along with the advancing knowledge of physiopathology, came new protocols of treatment that progressively started to include both systemic and local chemoprophylaxis, adequate parenteral nutritional support, continual physiotherapy in the acute stage of the disease, aggressive treatment of respiratory and cardiac complications, all of which we now know are an essential part of the treatment of burns (Artz et al. 1969, Humel et al., 1982).

Advancements in Anaesthesiology also helped: the widespread use of new techniques during bathing and dressing sessions curtailed the space of time before skin grafting could be undertaken (Wagner, 1981; Monafo, 1970).

However, the greatest ever achievement in the treatment of burns was early excision and grafting. In the sixties, Madame Janzekovic (1970) first suggested early tangential excision of burnt skin because it helped healing process. Early excision hinders the formation of granulation tissue which leads to the genesis of hypertrophic scarring (Borsetti et al., 1973). Early debridement of necrotic tissue is also associated with a decrease of the complication rate in the subsequent stages. Many experimental and clinical studies have actually proved that macromolecular complexes, released from burnt tissues, are responsible for multiple organ function impairment characteristically seen in burns, and facilitate the onset of serious complications such as sepsis and multiple organ failure (Echinard, 1982).

The second main point of current treatment is early wound coverage.

In recent years efforts have been directed at solving the biggest problem of extensive burns, namely the relative inadequacy of donor areas.

The use of mesh-graft dermatome was certainly a progress, but the real difference was made by the possibility of culturing autologous keratinocytes in the early eighties (Gallico et al., 1984). The known boundaries of wound coverage were overcome and patients who until then had no hope could be successfully treated.

Early coverage of raw surfaces does actually improve patients' general conditions. It does furthermore prevent local formation of granulation tissue, which is, as already mentioned, one of the main culprits in the process that leads to hypertrophic scarring.

Residual damage from the burn is certainly the main concern in survivors, and it affects both their recovery and quality of life (Linares, 1996).

This is what we have done in our Burn Centre, team-working with other researchers supported by the Piedmont Foundation for Studies and Researches on Burns, in the past ten years.

In the seventies, we conducted histological and biochemical studies on hypertrophic scarring. We subjected 40 patients to serial biopsy both in the acute stage and during the scar rearrangement process. A strong metabolic activity, resembling that seen in hypertrophic scars, was detected in granulation tissue (Angela et al., 1973). Biochemical studies aiming at measuring the degree of the activity of Proline-Hydroxylase in healthy skin, granulation tissue and hypertrophic scars revealed a marked increase in both granulation tissue and hypertrophic scars (Cavallero et al., 1973).

In 1983, we conducted serial histological studies on mesh-grafts to detect the difference between the areas covered by grafts strips and those undergoing spontaneous healing, where some formation of granulation tissue occurs, and we found that, in the latter, dermal papillae are absent after as long as 10 years (Teich-Alasia et al., 1982).

It is well known fact that wound healing is the result of a process involving mediators, cells and structural proteins that interact to repair injured tissues (Stella et al., 1989; Cohen et al., 1979; Janssen de Limpens et al., 1982).

We focused on the possibility that immunological factors could play a role in burn scars and, 10 years ago, together with the Human Anatomy and Genetics Departments of Torino University we started conducting studies which showed that, in pathological scar tissues, Langerhans cells increase in number and undergo morphological changes (Cracco et al., 1992), this is associated with white cells infiltrates. It must be noted that the presence of such infiltrates has been observed in many skin conditions (i.e. Lichen Planus, Psoriasis, Atopic Dermatitis, etc.) which typically feature ectopical expression of HLA class II antigens on keratinocytes. The abnormal expression of HLA DR molecules and their modulation in hypertrophic scars is associated with the presence of other activation molecules e.g. Intercellular Adhesion Molecule type 1 (ICAM-1) Interleukin 2 receptor (IL-2R) and CD36 antigens (Castagnoli et al., 1990, 1994, 1995b). Their expression is modulated mainly by cytokines produced by immunocompetent cells in response to a number of stimuli (Castagnoli et al., 1993).

Our results demonstrate that because of the ectopic expression of these various markers, hypertrophic scars can be classified in the group of dermatosis caused by the impaired immune response.

In particular, the presence of these signals on keratinocytes and fibroblasts strongly indicates that they have a key role in the pathogenesis that has been overlooked.

We believe that the pathogenesis of hypertrophic scarring can be explained in terms of abnormal interaction of the immune system with such cells. The production of cytokines normally involved in remodelling the extracellular matrix is impaired, and this disrupts the sequence of messages that mediate cells interactions (Castagnoli et al., 1993, 1995; Peruccio 1994).

It is still unclear whether the ultimate cause for hypertrophic scarring is the individual genetic susceptibility or the action of exogenous agents.

All the work done in this field increases our hope that something can be done to improve the life of burn sufferers.

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FACTORS INFLUENCING THE EARLY PREDICTION OF OUTCOME FROM BURNS

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SUMMARY

Objective: 1. To reexamine the predictive value of the variables usually used in admission scores in burned patients (age, total body surface area burned (TBSAB), full thickness burn (FTB), inhalation injury (IHT) and sex). 2. To evaluate whether risk factors (alcohol abuse (AA), nicotine abuse (NA)) or preexisting diseases influence outcome significantly.

Design: Retrospective study of prospectively collected data.

Patients: 498 burned patients admitted to the burn ICU within a 5 years period. The mean TBSAB was 29% and the mean age 38 years. 42% of the patients suffered burns greater than 30% and the incidence of IHT amounted to 43%.

Methods: Univariate analyses were used to determine the independent relation of the variables to mortality. The relative weight of the variables was estimated using the step - wise logistic regression model. An additional analysis of subgroups was performed using classification and regression trees (CART).

Results: The univariate analyses identified the following variables to have significant influence on mortality: age, TBSAB, FTB, IHT, sex, AA, NA, the combination of AA and NA, preexisting neurological diseases and cardiovascular diseases. The step-wise logistic regression analysis identified age and TBSAB to have the most important influence on the outcome. Of minor weight was IHT followed by FTB and sex. The weight of IHT was found to be 1.7 fold higher than the impact of FTB and sex. A significant influence of IHT was found in all patients, but especially in patients with a medium risk of death (20% - 45%) regarding age and TBSAB. In this group AA and NA additionally caused a significant impact on mortality. In patients with a higher or lower probability of survival AA and NA did not influence the outcome. The CART analysis identified TBSAB to be the most discriminative variable followed by age. In the group up to 20% TBSAB age was the only additionally significant variable regarding the outcome. In the group with a TBSAB between 20% and 60% age, sex and AA became important variables. In patients up to 72 years with a medium risk of mortality (20% - 70%) IHT, AA, combined AA and NA, sex, preexisting neurological diseases and cardiovascular diseases significantly influenced outcome. In older patients IHT was the only additional variable of importance.

Conclusions: The study demonstrates that besides the „classical“ variables of burn scores as age, TBSAB and IHT other variables such as sex, AA, NA and preexisting diseases have significant influence on the outcome. These variables especially gain important predictive value in patients with a medium risk of mortality.

ZUSAMMENFASSUNG

Faktoren, die die frühe Vorhersage der Prognose Schwerbrandverletzter beeinflussen

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Einleitung: Feste Bestandteile der gebräuchlichen Scoring-Systeme zur Abschätzung der Prognose Schwerbrandverletzter sind Alter und das Ausmaß der verbrannten Körperoberfläche (TBSAB). In einigen Scoring-Systemen werden zusätzliche Faktoren wie das Vorhandensein eines Inhalationstraumas (IHT), III.° Verbrennungen (FTB) und das Geschlecht verwendet, um die Vorhersagegenauigkeit zu verbessern. Vorerkrankungen werden in wenige Vorhersagesysteme aufgenommen. Alkohol- (AA) und Nikotinabusus (NA) werden nirgends berücksichtigt.

Ziel dieser Studie war: 1. Den Vorhersagewert der Faktoren zu überprüfen, die üblicherweise in Scoring-Systemen verwendet werden (Alter, TBSAB, IHT, FTB). 2. Ob andere Faktoren wie Geschlecht, Vorerkrankungen, AA und NA die Prognose signifikant beeinflussen.

Patienten und Methode: Prospektiv dokumentierte Daten 498 in Folge aufgenommener Brandverletzter wurden in der Studie analysiert. Die mittlere TBSAB lag bei 29%, und das mittlere Alter bei 38 Jahren. 42% der Patienten hatten Verbrennungen von mehr als 30% der Körperoberfläche und 43% der Patienten erlitten ein IHT. Die verwendeten statistischen Methoden waren: univariate Analysen, die schrittweise logistische Regression, Baumanalysen (CART) und Receiver-operating-characteristic (ROC) Kurven.

Ergebnisse: Die univariaten Analysen zeigten einen signifikanten Einfluß folgender Variablen auf die Mortalität: Alter, TBSAB, IHT, FTB, Geschlecht, AA, NA, Herz-Kreislauf-erkrankungen und neurologische Vorerkrankungen. Die schrittweise logistische Regression ergab, daß Alter und TBSAB den stärksten Einfluß auf die Prognose haben. Geringere Bedeutung kommt dem IHT, der FTB und dem Geschlecht zu. Das Gewicht des IHT ist annähernd zweimal größer als das von FTB und Geschlecht. Das IHT besaß prognostische Bedeutung bei allen Patienten. Besonders ausgeprägt war sein Einfluß jedoch bei Patienten mit einem mittleren Mortalitätsrisiko (20% - 50%). In dieser Patientengruppe zeigten auch AA und NA einen signifikanten Einfluß. Sie beeinflussten jedoch die Prognose der

Patienten mit geringerem oder höherem Mortalitätsrisiko nicht. Den Vorerkrankungen wurde kein Einfluß auf die Prognose zugesprochen. Auch die CART Analyse bestätigte die wichtige Rolle von TBSAB und Alter. Bei Patienten mit einem mittleren Mortalitätsrisiko und einem Alter unter 72 Jahren wurde die Prognose zusätzlich von AA, IHT, Geschlecht und vorbestehender Herz-Kreislauf-Erkrankungen und neurologischer Erkrankungen beeinflusst. Bei älteren Patienten war das IHT die einzige zusätzlich wichtige Variable. Zur Kontrolle der in der Studie verwendeten Methoden wurden ROC Kurven berechnet. Diese zeigten, daß die Ergebnisse der logistischen Regression und der CART Analyse zu einer Verbesserung der Selektivität im Vergleich zum Baux Score und dem Abbreviated burn severity index führt.

Schlußfolgerung: Die allgemein anerkannte prognostische Bedeutung der TBSAB und des Alters werden bestätigt. Dem IHT muß ein größeres Gewicht beigemessen werden. Die anderen Variablen wie Geschlecht, FTB, AA und Vorerkrankungen haben einen geringeren Einfluß auf die Prognose. AA und Vorerkrankungen gewinnen besondere Bedeutung in der Gruppe der Patienten mit mittlerem Mortalitätsrisiko.

Key words: burns, mortality, scoring methods, risk factors

Studies in trauma victims have led to the acceptance that the variables influencing patient outcome relative to injury are (1) host factors, (2) injury severity, (3) time until definitive care is provided, and (4) the quality of care (1-6). These variables have comparable impact on the outcome among burn patients. During the last decades attention has been directed mainly to the advances in the understanding of burn injury and the improvement of pre-hospital management and clinical care. However only modest efforts have been made to quantify the impact of host factors on morbidity and mortality of burn victims.

The quality of pre-hospital and in-hospital care are the only important factors affecting survival that can be improved. Host factors are intrinsic to the patient and constitute his physiological reserve. Some evidence exists, that in addition to age other host factors such as gender, preexisting diseases, chronic alcohol abuse (AA) and nicotine abuse (NA) influence survival following burn injury.

Scoring systems are widely used in trauma and burn patients to predict patient's outcome, for measuring changes in patients' conditions and for comparing patient samples. In burn patients age and the extent of burn injury are recognized to be of major predictive value in all admission scoring systems which are in general use. Some statistical analyses of burn mortality regard full thickness burns (FTB) (7-12) and inhalation injury (IHT) (10-12) to be important additional predictive variables. Regarding host factors apart from age, predictive significance is ascribed to gender in some prognostic systems (7-11, 13). The presence of preexisting illness or laboratory data are used to enhance the discriminating power in three models (12-14).

The aims of this study were (1) to reexamine the predictive value of the variables usually used in admission scores in burned patients (age, total body surface area burned (TBSAB), full thickness burn and inhalation injury) and (2) to evaluate whether host factors such as gender, preexisting diseases, alcohol abuse (AA) and nicotine abuse (NA) influence outcome significantly and would contribute to improve the accuracy of outcome prediction of burn scores.

MATERIALS AND METHODS

Prospectively collected data from the charts of 498 burn patients admitted to the burn ICU within a 5 year period were analyzed in this retrospective study. The characteristics of the patients are summarized in Table 1.

Table 1. Patient characteristics.

Number of patients (no.)	498
Female (no.)	122 (24.5 %)
Male (no.)	376 (75.5 %)
Mean age (years)	38
Mean TBSAB (%)	28.6
IHT (no.)	214 (43 %)

Table 2. Criteria of preexisting diseases.

Cardiovascular disease: cardiac insufficiency ischemic heart disease history of myocardial infarction hypertension and hypotension arteriosclerotic occlusive disease
Pulmonary disease: COPD asthma history of pneumonia or tuberculosis neoplasm
Neurological disease: convulsive disorders cerebrovascular diseases demyelinating diseases degenerative nerve diseases congenital diseases
Diabetes, gastrointestinal and renal diseases

Data reviewed included the „classical“ variables: age, TBSAB, presence of FTB, presence of IHT and outcome. Preexisting diseases were classified according to previously defined criteria (Table 2). Further host factors included into the analysis were gender, chronic AA and NA.

Chronic AA was supposed in patients consuming more than 60 g alcohol per day. The definition of NA was the consumption of more than 20 cigarettes per day. To estimate the influence of AA the data of 368 patients were available and for the calculation of the importance of NA the data of 366 patients could be included. The abbreviated burn severity index (ABSI) and the modified Baux score were calculated after each patient's discharge.

Univariate statistical analysis was done to estimate the independent relation of the variables to mortality. Chi-square analysis were calculated for the discrete variables gender, presence of IHT, FTB, preexisting illness, AA and NA. T-test and Man-Whitney U-test were used to examine the continuous variables age and TBSAB. Values of $p < 0.05$ were considered statistically significant. The relative weight of the variables was estimated using the step - wise logistic regression model. An additional analysis of subgroups was performed using classification and regression trees (CART). Finally receiver - operating - characteristic (ROC) curves were used to determine whether the analysis of additional host factors improves the accuracy of the prediction of mortality.

RESULTS

Univariate analysis

The univariate analyses identified the following variables to have significant influence on mortality: age, TBSAB, FTB, IHT, gender, preexisting cardiovascular diseases and neurological diseases AA, NA and the combination of AA and NA (Table 3). The host factors pulmonary ideas and the group of diabetes, gastrointestinal and renal diseases demonstrated no significant differences between survivors and non-survivors.

Table 3. Results of the univariate analyses.

	survivors	non-survivors	p
age (years)	34.7	49.9	< 0.01
TBSAB (%)	20.2	49.9	< 0.01
patients			
with FTB	237 (63.7%)	135 (36.3%)	<0.001
without FTB	119 (94.4%)	7 (5.6%)	
IHT			
with	36 (16.8%)	178 (83.2%)	<0.001
without	257 (90.5%)	27 (9.5%)	
gender			
female	70 (57.4%)	52 (42.6%)	<0.001
male	286 (76.1%)	90 (23.9%)	
cardiovascular dis.			
with	50 (58.1%)	36 (41.9%)	<0.01
without	306 (74.3%)	106 (25.7%)	
neurological dis.			
with	45 (56.25%)	35 (43.75%)	< 0.01
without	309 (74.3%)	107 (25.7%)	
chronic AA*	43 (55.1%)	35 (44.9%)	<0.01
no AA	226 (77.9%)	64 (22.1%)	
smoker**	118 (64.8%)	64 (35.2%)	<0.001
non-smoker	149 (81.0%)	35 (19.0%)	

* n = 368; ** n = 366

Step-wise logistic regression analysis

The step-wise logistic regression analysis included the variables: age, TBSAB, IHT, FTB, and the four groups of preexisting diseases. Age and TBSAB were identified as having the most important influence on the outcome. Of minor weight was IHT followed by FTB and gender. The weight of IHT was found to be about two fold higher than the impact of FTB and gender (Table 4). No predictive value was assigned to the preexisting diseases.

Table 4. Results of the first step-wise logistic regression analysis.

	coefficient	SD
age	0.076	±0.011
gender	-0.870	±0.360
TBSAB	0.086	±0.011
IHT	1.740	±0.350
FTB	0.920	±0.490

The second step-wise logistic regression analysis additionally included the variables AA and NA. Three hundred and sixty-six patients whose data were completely available were included. The result was similar (Table 5). But AA additionally gained high predictive value ($p < 0.01$).

Table 5. Results of the second step-wise logistic regression analysis.

	coefficient	SD
age	0.068	±0.012
gender	-0.60	±0.410
TBSAB	0.080	±0.013
IHT	1.400	±0.420
FTB	1.550	±0.790
AA	0.960	±0.390

The calculation of the probability of survival of the patients using the ABSI showed complete survival of the patients in the groups with a predicted survival rate greater than 90%. No survival was observed in the group with an expected survival of 0%. Within the five ABSI groups with an estimated survival of 30% to 90% the observed mortality reached from 7% to 67%. In further analyzes special attention was directed to these groups. A significant influence of IHT was found in all patients, but especially in patients with a medium risk of death (20% - 50%). In this group AA and NA additionally caused a significant impact on mortality. In patients with a higher or lower probability of survival AA and NA did not influence the outcome.

CART analysis

In the first CART analysis all variables were included. This analysis identified TBSAB to be

the most discriminative variable followed by age. In the group up to 20% TBSAB age was the only additionally significant variable regarding the outcome. In patients older than 72 years mortality increased from 7.4% to 66.7% ($p < 0.05$). A similar influence of age was observed in patients with a TBSAB between 20% and 40%. The mortality of the patients older than 72 years rise from 33% to 88.9% ($p < 0.05$). Patients older than 52 demonstrated a significantly increased mortality suffering burns between 40% and 60% TBSA (34.6% versus 95.2%). In this group a high impact of AA was identified, raising the mortality from 26.2% to 70%. In the groups with a TBSAB between 20% and 60% gender also influenced outcome.

For the second CART analysis patients were classified using the ABSI. Patients with a low risk of mortality ($> 10\%$) demonstrated some influence of IHT and AA regarding outcome. In the patients with a mortality risk of 20% to 40% AA gained significant influence. In the groups with a higher risk female gender significantly increased the probability of death.

Special attention was directed to the four ABSI groups with a probability of survival between 90% and 30%. The CART analysis of these „borderline groups“ identified significant influence of AA, IHT and age in the groups with a probability of survival between 80% and 60%. In the groups with lower probability of survival age and gender gained significant influence.

In a further CART analysis the patients of the borderline groups were combined to reach a better statistical significance. Age demonstrated the most significant impact. In patients younger than 72 years AA additionally showed significant influence ($p < 0.01$). In patients without history of AA gender, IHT and cardiovascular diseases further influenced outcome. In patients with history of AA preexisting neurological disease further decreased probability of survival. In patients over 72 years major influence on survival was assigned to IHT, reducing the survival to 0%.

Additional analyses demonstrated a significant influence of AA in the groups with a medium risk of mortality (20%-40%). NA influenced probability of survival in none of the borderline groups.

ROC curves

To control the reliability of the methods used in this study the specificity and sensitivity of the Baux score, ABSI, step-wise regression analysis and CART analysis were compared using ROC curves.

The ROC curve (Fig. 1) of the values calculated using the Baux score already demonstrates a considerable selectivity. The ABSI increases the accuracy of prediction, including more variables into the calculation than the Baux score. A further increase of selectivity can be reached using the step-wise regression analysis in comparison

to the ABSI. Comparable values are reached using the results of CART analysis. This may be attributed to the adaptation of the regression analysis and CART analysis to the patients examined in the study.

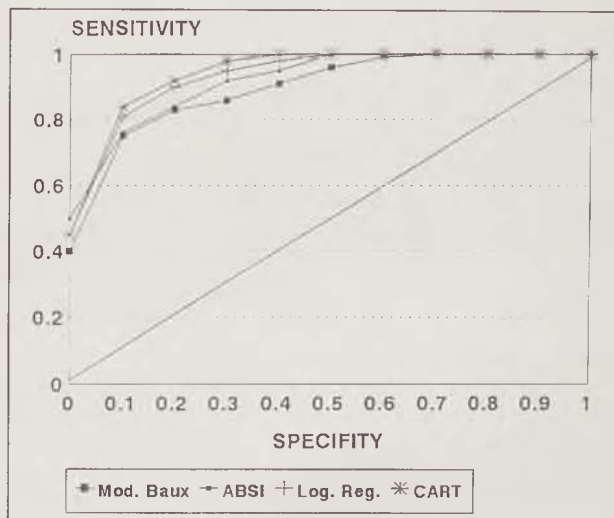


Fig. 1. ROC - curves

DISCUSSION

Advances in burn care have led to an impressive increase of survival during the last decades. Nevertheless major burns remain associated with high mortality rates. Score calculation in burn patients may provide valuable information. Scores enable stratification of patients and allow objective comparison of similar or dissimilar groups of patients. They facilitate the in-depth review of specific groups of patients or provide informations concerning changes or improvements in patient outcomes. Finally scores may be used to determine adequacy and appropriateness of patient care (15).

In all burn scores major influence on mortality was attributed to age and TBSAB. In 1949 Bull and Squire (16) determined the probability of survival depending on age and TBSAB. The importance of FTB was mentioned but no further significance was then attributed to this by the authors. This score was modified in 1979 by Stern and Waisbren (17) using the same variables. Further studies of Pruitt (18) and Rittenbury (19) determined the influence of age and TBSAB on survival using the probit analysis. The analysis of Rittenbury recognized the influence of FTB. Additionally race was found to be a variable of significant influence. No importance was attributed to gender.

In 1979 Zawacki (12) used the step-wise discriminant analysis to determine 6 out of 17 variables to have major influence on the probability of survival. In addition to age and TBSAB, FTB, airway edema, abnormal PaO₂ and the history of prior bronchopulmonary disease were estimated,

to have influence on mortality. The variables gender and race were not found to be important. The calculation of the ABSI (10, 11) was done using the multivariate logistic regression analysis. Age, TBSAB, FTB, IHT and gender were identified as having major predictive value.

The importance of the variable FTB was finally confirmed by the study of Roi (9). Two prognostic models were developed. One of these models additionally used the variable FTB. The predictive value of the model including the variable FTB was proven to be superior. Several studies (20-22) demonstrated the weight of IHT on mortality. The influence of gender was confirmed in other studies (7-9, 10, 11, 13). Another approach was developed by Marshall (23) using multiple subsystem failure to enhance the predictive accuracy.

Other factors such as preexisting illness or laboratory data are recognized to be able to enhance the discriminating power of scoring systems (13, 14). But these data were not estimated to change the predictive indices in most patients (17, 24). Of the admission scores in use nowadays only ZS includes one preexisting disease. However clinical experience clearly demonstrates that preexisting illness and risk factors like AA and NA may lead to a divergence from predicted survival.

A side product of this study consists of the first validation of the ABSI in a distinct patient population. The first aim of the study was to examine the influence of host factors such as preexisting illness, AA and NA on survival after burn injury.

The results of the univariate analysis confirm the major influence of TBSAB and age on survival noticed already in other studies. The weight of TBSAB is accentuated by the logistic regression analysis and the CART analysis. The CART analysis illustrates TBSAB to be the most significant predictive variable. The influence of age is validated by the logistic regression and CART analysis.

The univariate analysis substantiates the suspicion that IHT strongly influences survival in the whole patient population. The logistic regression analysis demonstrates the weight of IHT to be 1.7 fold higher than the impact of FTB and gender. Regarding the CART analysis there are some hints that a special importance exists in the borderline groups. In these groups presence of IHT causes a considerable mortality shifting. The high impact of IHT disappears in patients with a decreasing probability of survival. This finding is supported by the results of a study of Tryba (25).

Gender is estimated by the regression analysis to be a variable of minor weight. In the CART analysis increasing influence is found with increasing age, TBSAB and mortality risk. The univariate analysis identifies the presence of FTB to have significant influence on survival. The logistic regression analysis attributes a minor weight

to FTB which can be compared with the estimation of the ABSI. Surprisingly FTB never appears in any CART analysis as an additional variable. The accurate weight of this variable can not be determined in this study and the possibility of overestimation exists. Regarding the estimation of the weight of preexisting illness some problems exists due to the small sample size of these groups. The univariate analyses attribute increasing mortality to the presence of cardiovascular and neurological diseases. The logistic regression analysis attributes influence to preexisting bronchopulmonary diseases. The CART analysis demonstrates some impact of preexisting cardiovascular and neurological diseases in the borderline groups in patients younger than 72 years. The results of the study are not able to support the inclusion of preexisting diseases in a burn score. But there exist subgroups with increased importance of preexisting diseases.

The univariate analysis showed a significantly increased mortality caused by AA, NA and the combination of both. Logistic regression analysis attributed more predictive power to AA than to the variable gender. NA was not found to have significant weight by the logistic regression analysis. The CART analysis demonstrates that the variable AA gains some weight in the borderline groups with a medium risk of mortality (20%-40%). The CART analysis failed to identify selective properties in any of the subgroups. The accurate estimation of the weight of AA and NA is compromised by small sample sizes of these groups. Comparable to preexisting illness some importance of these variables seem to exist, especially in selected subgroups of patients.

The ROC curves demonstrate some improvement of sensitivity and selectivity using the results of the logistic regression and CART analysis. But these results need further validation in studies examining distinct patient populations.

In conclusion this study provides a validation of the ABSI. The well known major importance of the „classical“ variables of burn scores as age and TBSAB is confirmed. Additionally major weight must be attributed to IHT. Other variables like FTB, gender, AA, NA and preexisting diseases have some influence on the outcome. The variables AA and preexisting illness especially gain important predictive value in special subgroups of patients. The subgroup identified by this study are those patients with a medium risk of mortality.

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DEVELOPMENT AND UTILIZATION OF A PSYCHOMETRIC INSTRUMENT FOR MEASURING QUALITY OF LIFE IN BURN PATIENTS, 1976 TO 1996

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SUMMARY

Our Burn Specific Health Scale was initially developed in 1978. Using a number of existing health scales, including the sickness impact profile, a depression scale, and the activities of daily living scale, and a large number of burn specific items derived from staff and patients, we eventually developed an 80 item instrument. This instrument was divided into four domains each containing 20 items of equal weight. The instrument was validated sequentially with intrarater, interrater and global validation systems, and subsequently compared with a number of other health and mental scales during which it performed very well.

We now have longitudinal data which link this measurement system of quality of life to pre-injury educational level, to post-injury, stress disorder and predictability of return to work. The results indicate that total burn size has little to do with quality of life after recovery, and that a number of other factors play a bigger role, which will be presented.

ZUSAMMENFASSUNG

Die Entwicklung und Verwendung der psychometrischen Skala für die Messung der Lebensqualität der verbrannten Patienten

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Die spezifische gesundheitliche Skala für das Verbrennungstrauma wurde ursprünglich im J. 1978 entwickelt. Sie geht von den zahlreichen schon existierenden Gesundheitsskalen aus, einschliesslich des Krankenstand simpaktes, der Depressionsskala und der täglichen Aktivitäten, wobei die erhebliche Zahl der spezifischen Elementen aus der Verbrennungsproblematik von den Vorschlägen der Patienten und des Personals abgeleitet wurde. Danach wurde 80 Ansätze beinhaltende Skala entwickelt. Diese Skala wurde in vier Gebiete geteilt, wobei jedes Gebiet 20 Ansätze derselben Wichtigkeit beinhaltete. Die Skala wurde durch das Intraratersystem und das zusammenfassende überprüfende System bewiesen, zusätzlich wurde sie mit einer bestimmten Zahl der weiteren Gesundheits- und Mentalskalen verglichen, und sie bewährte sich sehr gut.

Nun haben wir die longitudinalen Daten, die das Messungssystem der Lebensqualität mit dem Ausbildungsniveau vor der Verletzung, mit dem Zustand nach der Verletzung, mit den Stresstörungen und mit dem wahrscheinlichen Berufsrückkehr vergleichen. Die Ergebnisse zeigen, dass der gesamte Umfang der Verbrennungen die Lebensqualität nach der Genesung nicht beeinflusst, sondern dass eine grössere Rolle die weiteren Faktoren spielen, die präsentiert werden.

Key words: measuring quality of life, burns

The need became apparent over two decades ago for a standardized and psychometrically sound instrument that was capable of measuring both the clinical impact of a broad range of burn morbidities as well as demonstrating the advantages offered by a multidisciplinary burn team. The mortality rate in patients hospitalized in the U.S. for burn injuries had dropped to below 10% in the 1970's (1). At that point the mortality rate was so low that it was difficult to clearly demonstrate mortality benefits in burn centers com-

pared with general hospitals. Therefore, in attempting to demonstrate the need for burn centers and the efficacy of the burn team, the focus was redirected towards reducing morbidity, both acute and chronic, especially as it impacted health-related quality of life.

Burn injury can profoundly effect the human organism: disrupting organization and functioning from the basic level of the cell and the organ system to the complex and often ambiguous level of the psychological and social systems. Impair-

ment on any of these levels can be either acute or chronic and can limit functioning in many spheres of functioning (i.e., physical, psychological, social, vocational). Common acute morbidities include systemic sepsis, wound infection, ARDS and renal failure, all of which have the potential for prolonged sequelae such as cardio-pulmonary and muscular deconditioning. Frequent chronic morbidities include hypertrophic burn scars, heterotopic ossification, limb loss and other deformities. These morbidities can limit function of key body parts such as hands, feet, nose, ears and genitalia. Quality of life in various spheres of functioning can be effected by these morbidities for example by limiting range of motion (2), by altering body image satisfaction and sexual adjustment (3) and by distorting perceptions of the manner in which the social network interacts with the burn survivor and responds to alterations in appearance (4). Furthermore, the traumatization that occurs at the time of the burn injury can produce frank psychopathology in its own right such as post traumatic stress disorder and major depression (5).

The standard approach to measuring quality of life has been to utilize both a generic and a disease-specific instrument. However, in the 1970's the technology had not advanced very far. Few generic measures existed and knowledge of the psychometric properties of those measures which did exist was limited. The decision was made to develop a burn-specific quality of life measure that could be utilized to both assess the impact of the burn in a broad range of functional domains, and to quantify the effect of multidisciplinary burn care. The burn survivor was already known to have rather unique challenges (e.g., burn scar disfigurement, scar contractures causing limited range of motion) that impact both psychosocial and physical adjustment (6). In fact, we had pilot data which indicated that although 85% of employed burn survivors considered themselves to be rehabilitated at one year postburn, only 65% of them were back to work (7). These data informed us that the process of recovering from a severe burn injury was more than a simple matter of healing the wound and regaining physical function.

METHOD

Item selection and reduction. The Burn Specific Health Scale (8) was developed to assess the postinjury adjustment of adult burn patients. To the best of our knowledge, a quality of life measure of pediatric burn survivors has yet to be developed although the American Burn Association and the Shriners Burn Institutes have recently embarked on a joint venture to create one. The first step in creating the BSHS was to generate a comprehensive item pool which would in-

clude all aspects of postburn adjustment. In our first item pool we included all the items from three commonly used generic measures that assessed different aspects of quality of life in medical patients. These measures included the General Well Being Schedule (GWB) (9) the Sickness Impact Profile (SIP) and the Index of Activities of Daily Living (IADL) (10). These scales were reduced to their constituent items which created a total of approximately 200 items. In addition, we conducted interviews with experts (i.e., burn center staff) and consumers (i.e., burn survivors) asking them to rationally generate items which might pertain to a burn survivor's recovery and quality of life. After eliminating duplicated items and rewording others, this process yielded an additional 189 items.

Table 1. Median score and Q value for each instrument.

Instrument	Number of items	Median score	Median Q value
Sickness impact profile	136	6.5	3.4
Activities of daily living	6	10.6	1.0
General well being index	67	7.8	2.7
Burn-specific items	175	7.5	3.0

Note: N = 24 respondents.

The next phase in the development of the BSHS, in the tradition of the theoretical-rational method of scale development, involved selecting a second panel consisting of 35 experts and consumers to evaluate and rate the relevance of each item in regards to a burn survivor's quality of life. The experts came from varied professional groups including medicine, occupational therapy, physical therapy, nursing, social work, and psychology. The consumers were 20 burn survivors carefully selected to be representative of type and size of burn injury and time elapsed since the burn. The panel was asked to rate each item, on an 11 point scale, the degree to which the item was relevant to the quality of life of a burn survivor (0 = not relevant at all, 11 = totally relevant). The items were then ranked based on the median scores assigned by the judges and the 80 items which received the highest median ratings were retained (11). In the final version of the instrument a number of duplicate and poorly worded items were eliminated and some questions were added to better differentiate the four domains measured by the BSHS. In its current form the BSHS is an eighty item questionnaire measuring four domains: physical functioning (largely activities of daily living), mental functioning (functional impairment due to psychological distress), social functioning (social, family and sexual impairment caused by the burn and its sequelae) and, general functioning (presence of psychosomatic distress such as pain, itching, lethargy) (12).

Table 2. Rank order listing of items with a median score of 9.0 or higher.

	Number of items	% of items of original scale
SIP	6	4.4
ADL	6	100
GWB	13	19.4
BURN	24	13.7

Internal consistency. The internal consistency/reliability of each of the BSHS subdomains as measured by the alpha coefficient has been sufficiently high (physical health, .86; mental health, .92; social functioning, .55). The test-retest reliability for patients who were administered the BSHS twice within one week was high ($R = .89$, $P < .01$). Interrater reliability, tested by have two different observers administer the BSHS to the same patients, within two days, was adequate ($R = .78$, $p < .05$).

Validity. Central to the validity of an instrument is how well it relates to other indices of what it purports to measure (i.e., criterion-related validity). The BSHS has been shown to relate well to global ratings of postburn adjustment made by expert clinicians (12) supporting the convergent validity of the instrument. The physical subscale correlated with blinded expert rating of percent of physical recovery ($r = .60$, $p < .05$) and the psychological subscale correlated with blinded expert rating of percent of psychological recovery ($r = .78$, $p < .05$).

More recently, the BSHS has been shown to be sensitive to expected differential group reactions to severe burn injury. For example, we demonstrated that subjects with a preburn history of psychiatric illness had worse scores on the BSHS psychological, social and general subscales at the time of discharge than did those with no such history. This suggests that their preburn vulnerability to stress was instrumental in early post-injury re-

covery processes (13). However, by one year post-burn the individuals who had no history of psychiatric illness prior to the injury had regressed in their BSHS scores and no longer differed significantly from their peers who did have a psychiatric history. This finding suggested that the stressful experience and sequelae of a burn injury may be chronic, and can erode even the resources provided by the wellfunctioning personality and social structures of those individuals who were premonstrably healthy and initially well adjusted after the injury. Of more relevance to the current point, these data provide support for the validity of the BSHS since the instrument was found to be related to gross factors expected to affect adjustment (i.e., preburn psychopathology), and was also found to be sensitive to changes in functioning over time.

In data not published elsewhere, the BSHS was also found to be sensitive to differences in quality of life of those who were employed versus unemployed at twelve months following discharge. The Psychological subscale was significantly higher in those who were working ($xxx = 114$) compared to those who were not ($xxx = 86$) ($F = 6.7$, $p < .02$). The Social subscale approached statistical significance as well, with those working ($xxx = 58$) where scoring higher than those who were not ($xxx = 46$) ($F = 3.55$, $p < .09$). Neither the Physical nor the General subscales differed between the employed and unemployed groups. This pattern of results suggests that the employment status of burn survivors was a pioneering effort in the development of injury specific quality of life measures and it continues to be a useful instrument in a multi-system evaluation of the burn survivor. The methods utilized to generate the items are still considered quite strong. Beginning with a clear understanding of the target construct and over-inclusiveness in initial item selection (14) the development was guided by sound psychometric principles. In fact, the use of a large sample of experts from both the burn clinician

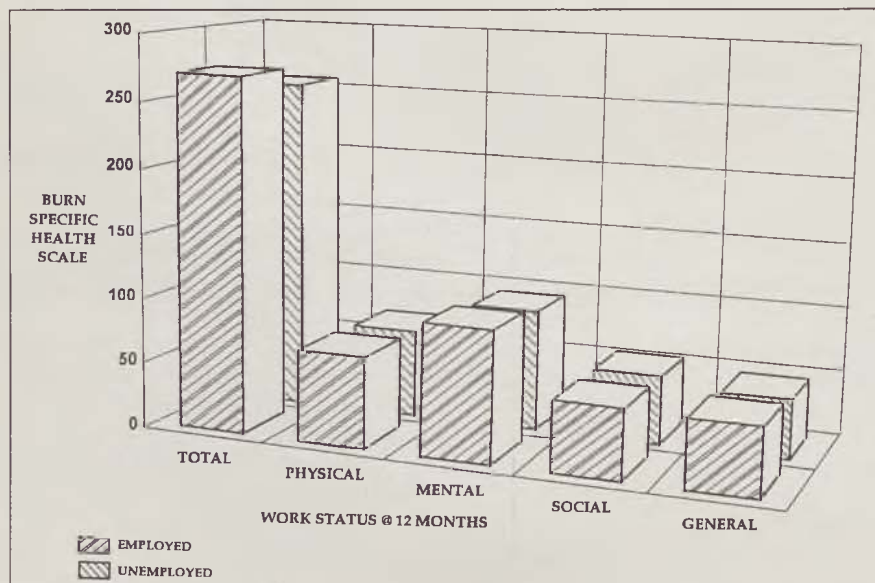


Fig. 1. Burn specific health scale at 12 months post discharge.

and burn survivor points of view was, and remains, a highly laudable approach to instrument development. Using many items from other scales with demonstrated reliability and validity enabled the originators of the BSHS to build upon the foundation laid by those earlier efforts.

The BSHS has performed well in those tests of its psychometric properties that have been conducted, however, the technology of test construction continues to improve (14) and, like other medical assessment instruments, quality of life instruments will continue to improve. While the BSHS has demonstrated its clinical utility there remains much that can be done to improve the psychometric properties of the instrument. Such development would enable the users of the instrument to have more knowledge of what certain scores mean (i.e., validity) and greater confidence in those scores (i.e., reliability). The next phase of test development should include a factor analysis of the scale in order to demonstrate unidimensionality of each of the scales. Confirmatory factor analysis would then follow with a second sample to determine the stability of this factor structure. This process would yield a reliable factor structure. Demonstration of convergent/discriminant validity could then be accomplished by assessing whether the scales correlate with measures they should correlate with and remain uncorrelated with unrelated measures. For example, the Physical scale should correlate with size and depth of the burn while the Psychological scale should not. Likewise the Psychological subscale should correlate with measures of depression while the Physical subscale should not. „Good scale construction typically is an iterative process involving several periods of item writing, followed in each case by conceptual and psychometric analysis“ (14). We hope that the BSHS serves to continue to challenge the field to provide better assessment and to guide treatment in order to increase sensitivity regarding quality of life issues.

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FLUID REPLACEMENT IN BURNED PATIENTS

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SUMMARY

Burn injury involves a large amount of water, electrolytes and proteins loss through the burn wound. For this reason, to avoid shock, a wide infusion of fluid is necessary in the first hours after trauma. Many reanimation formulas were proposed in the past years, with different composition: saline, colloids, plasma. The authors have studied 40 burned patients admitted in Verona Burn Center within 4 hours after burn, with burns over 30% of the body surface area. Twenty of them were treated with Baxter reanimation formula (ringer lactated saline, RLS) while the others with Monaflo hypertonic lactated saline (HLS), modified by Milan Burn Center. The two randomized groups were assessed and compared.

In RLS group total fluid volume infused was higher while sodium requirements was lower than in HLS patients, with statistically significant difference ($p < 0.01$). On the contrary, in HLS group, potassium administered was perhaps twice if compared with the other. Haematocrit, urine output and urine osmolality were adequate in both the groups, and did not showed statistical differences, such as serum proteins concentration, that was low in all patients, while a significant difference was noted in urine osmolality ($p < 0.01$). A metabolic alkalosis was present in HLS patients, while, on the other hand, serum nitrogen was significantly higher ($p < 0.05$), in the first 48 hours after burn, in RLS group.

Patients were assessed for pre-existing diseases too, and data showed that complications were lower in HLS than in RLS group.

HLS resuscitation formula guarantees a good electrolytes balance with lower fluid load, reducing tissue oedema and complication rate. Mortality rate was higher in HLS, may be for an higher Roy index in this group.

ZUSAMMENFASSUNG

Der Flüssigkeitsersatz bei den verbrannten Patienten

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Das Verbrennungstrauma ist mit einem erheblichen Verlust von Wasser, Elektrolyten und Proteinen verbunden. Für die Milderung des Schocks ist eine erhebliche Wasserversorgung in den ersten Stunden nach der Verletzung notwendig. In den vorigen Jahren wurden verschiedene Resuscitationsformeln von unterschiedlichen Strukturen: die physiologische Lösung, die Kolloiden, das Plasma vorgeschlagen. Die Autoren studierten 40 verbrannte Patienten, die in den ersten vier Stunden nach der Verletzung ins Verbrennungszentrum in Verona mit mehr als 30 - prozentiger Beschädigung der Körperoberfläche aufgenommen wurden. 20 von ihnen wurden mit der Baxterresuscitationsformel (Ringer - Laktat, RLS) behandelt und die anderen Patienten mit Hilfe der Monafloformel (die hyperthionische Lösung mit Laktat, HLS), die vom Verbrennungszentrum in Milano modifiziert wurde. Es wurden zwei zufällige Komplexe gebildet und verglichen. Bei der RLS Gruppe war die gesamte Flüssigkeitsmenge höher, wobei der Bedarf an Natrium niedriger war als bei den HLS Patienten (mit statistisch bedeutsamer Differenzierung $p < 0.01$). Und im Gegenteil bei der HLS Gruppe, im Vergleich mit der anderen Gruppe, wurde 2 mal mehr Kalium eingegeben. Das Hämokrit, die Urinausgabe und die Urinosmolarität waren in beiden Gruppen entsprechend und erwiesen keinen statistischen Unterschied. Die Konzentration von Serumproteinen war niedrig bei allen Patienten, wobei bei der Urinosmolarität ein signifikanter Unterschied ($p < 0.01$) betrachtet wurde. Die metabolische Alkalose war bei den HLS Patienten vorhanden, wobei der Serumsstickstoff in den ersten 48 Stunden nach der Verbrennung bei der RLS Gruppe signifikant höher ($p < 0.05$) war. Die Patienten wurden auch aus der Sicht der vorherigen Erkrankungen geteilt und die erworbenen Daten erwiesen eine niedrigere Komplikationsrate bei der HLS Gruppe als bei der RLS Gruppe. Die HLS Resuscitationsformel garantiert ein gutes elektolytisches Gleichgewicht, eine niedrige Flüssigkeitsladung, wodurch das Gewebeödem herabgesetzt ist und eine niedrige Komplikationsrate. Die Mortalität war höher bei der HLS Gruppe, was durch den höheren Roysyndrom in dieser Gruppe verursacht werden konnte.

Key words: fluid replacement in burns

Burn trauma involves a wide vascular and tissue damage, resulting in an enormous fluid through burn wounds, that is proportional to the injured areas. The first goal in burn resuscitation

is to preserve the organism normal activity and to reduce complications (1, 4, 9, 12). In the last decades several reanimation formulas have been proposed and utilized (3, 5, 23, 24). Actually, how-

ever, there are different opinions about their composition.

Some authors prefer to give only saline solutions in the first 24 hours, some others colloid solutions; a combined reanimation formula with both saline and colloid is on use too (2, 6, 13, 16, 22).

In this study two groups of 20 burn patients treated with hypertonic saline and saline plus colloid solutions are compared, with mortality and complication rate analysis.

MATERIAL AND METHODS

Forty patients, with burns over 30% of the body surface area (B. S. A.) admitted within 4 hours after trauma to Verona Burn Unit were analyzed. They were randomly divided in two different groups. The first group was treated with Ringer Lactated Saline (RLS) (3, 4), and the second with Monafo (16) Hypertonic Lactated Saline (HLS) resuscitation, modified by Milan Burn Center (Tables 1 and 2).

Table 1. Burn patients data.

	Ringer Lactated Saline (RLS)	Hypertonic Lactated Saline (HLS)
Number of patients	20	20
Average age	52 ± 12,8	56 ± 17,3
Total Burn (%)	48 ± 7	52 ± 8
Deep Burn (%)	31.5 ± 5	40.5 ± 6
Roi Index	0.71	0.81

Table 2. Monafo hypertonic lactated saline reanimation formula (HLS), modified by Milan Burn center.

FIRST 24 HOURS * Hypertonic solution (with 215 mEq/l Na) The total amount of HLS to be infused can easily be obtained dividing Na requirement by 215 mEq/l Na requirement = 0.6 x body weight x % of burn
SECOND 24 HOURS * Plasma (50%) and Saline Acetate Solution or Levulose (50 %)

In both groups the following parameters were assessed:

- total infused fluid
- serum and urine electrolytes concentration
- sodium and potassium balance

- urine volume
- haematocrit
- serum and urine osmolarity
- urine/serum osmolarity ratio
- acid/base balance
- serum protein level
- nitrogen balance

Furthermore complication and mortality rate in the different groups were studied and statistical evaluation using CHI square test was performed.

RESULTS

The total fluid volume required in patients with Baxter resuscitation formula (RLS) was significantly greater ($p < 0.01$) than that administered with Monafo modified (HLS) (Fig. 1), while sodium supply (mEq/Kg/%burn) was significantly higher in HLS treated patients ($p < 0.01$) (Fig. 2a). In this group elevation of sodium concentrations lasted for the first 96 hours (Fig. 2b).

Total potassium amount administered with HLS was perhaps twice if compared with that given with RLS (Fig. 3a). On the contrary, in RLS group, potassium concentration remained within acceptable limits for the first 48 hours, decreasing in the second 48 hours (Fig. 3b).

Urine output in both groups was adequate, slightly lower in the HLS reanimated patients, without any statistical difference (Fig. 4).

Haematocrit showed a difference between the two groups, but not statistically significant (Fig. 5). The same was true for serum osmolarity (Fig. 6). On the other hand, a significant difference ($p < 0.01$) was observed for urinary osmolarity (Fig. 6b). This variation influenced the urine/serum osmolarity ratio (Fig. 7).

All the patients have presented low serum proteins concentration, but this was more marked in HLS group (Fig. 8).

A metabolic alkalosis was noted in the HLS treated patients during the first 24 hours.

Serum nitrogen was significantly higher, in the first 48 hours, in RLS group ($p < 0.05$) (Fig. 10).

With the aim to study complications and mortality rate between the two groups, we selected the patients with preexisting diseases before trauma from the others. We noted that mortality rate was higher in HLS than in RLS group. The

Table 3. Complication and mortality with and without pre-existing diseases.

	Patients with pre-existing diseases (n = 19; RLS = 8 HLS = 11)		Patients without pre-existing diseases (n = 21; RLS = 12 HLS = 9)	
	RLS	HLS	RLS	HLS
Mortality	2/8 (25.0%)	4/11 (36.4%)	1/12 (8.3%)	1/9 (11.1%)
Complication	4/8 (50.0%)	3/11 (33.3%)	3/12 (25.0%)	1/9 (11.1%)
Roi Index	0.76	0.85	0.69	0.78

reason could be connected to an higher Roi index in this group. On the contrary, complications rate was lower and statistically significant in HLS resuscitated patients ($p < 0.05$) (Table 3).

Patients without preexisting diseases showed complication rate lower in HLS than in RLS group.

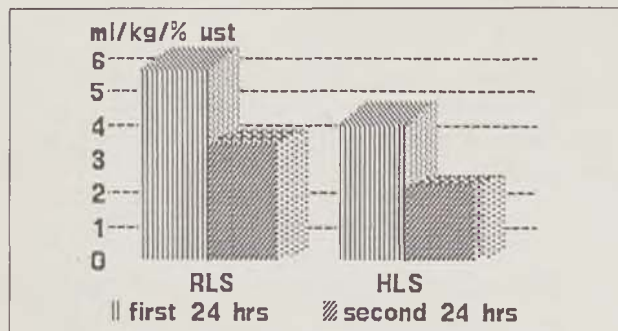


Fig. 1: Total fluid infused in the first 48 hours with the two different protocol (ml/Kg/%B.S.A.).

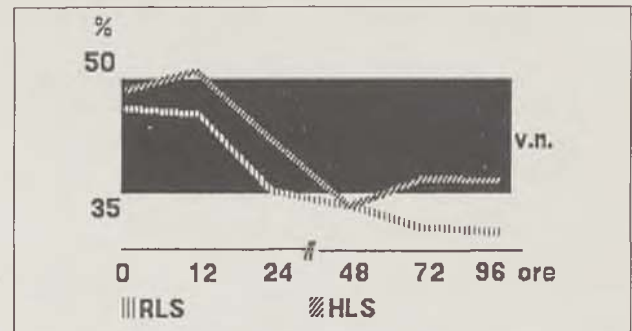


Fig. 5: Haematocrit variation (%) in the first 96 hours in both the groups of patients.

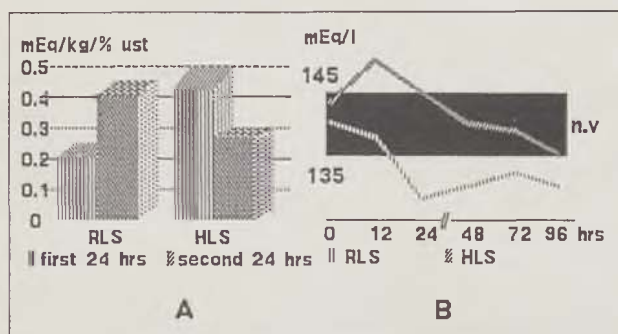


Fig. 2: A - Total sodium infused in the first 48 hours with the two different protocols (ml/Kg/%B.S.A.).
B - Sodium serum concentration in the first 96 hours.

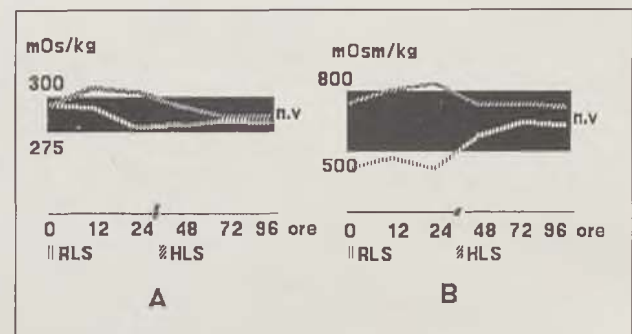


Fig. 6: A - Serum osmolarity variation.
B - Urine osmolarity variation.

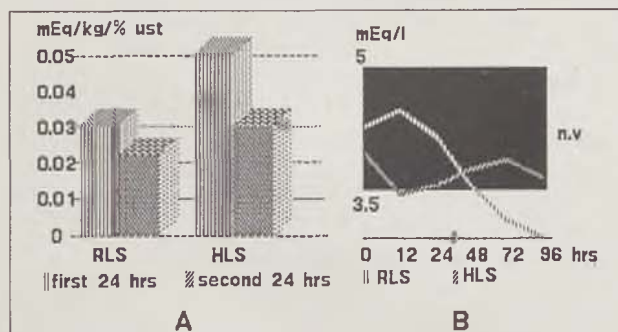


Fig. 3: A - Total potassium infused in the first 48 hours in the two groups of patients (ml/Kg/%B.S.A.).
B - Potassium serum concentration in the first 96 hours.

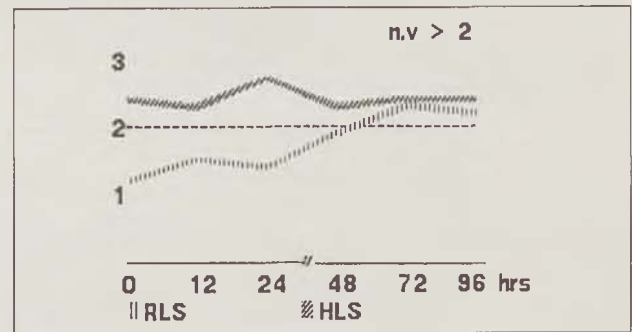


Fig. 7: Urine/serum osmolarity ratio in both the groups of patients.

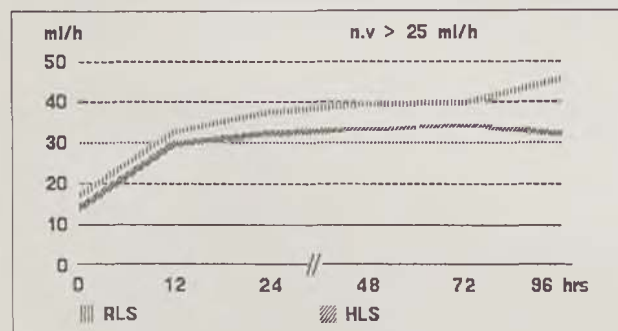


Fig. 4: Urine output (ml/h) in the first 96 hours.

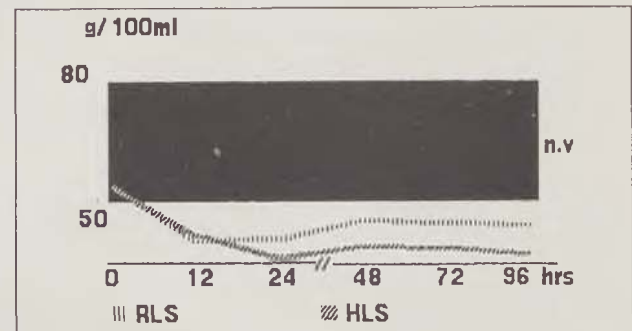


Fig. 8: Serum proteins concentration in the first 96 hours.

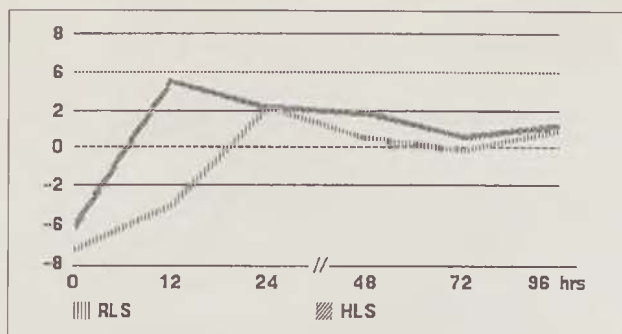


Fig. 9: Base excess variation during the reanimation period.

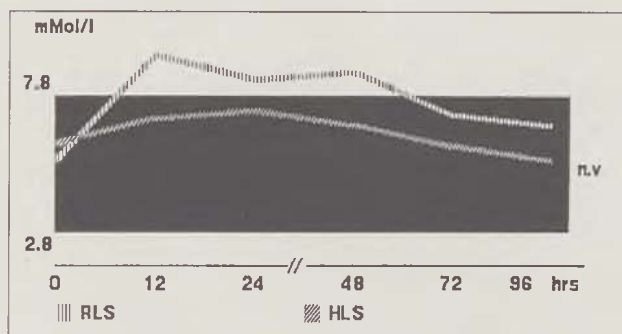


Fig. 10: Serum nitrogen variation in the first 96 hours after burn.

DISCUSSION

More than 90% of the body fluids is represented by water, while sodium is about 90-95% of the total electrolytes. Extracellular fluids are therefore influenced by sodium osmotic action (20). On the other hand, sodium concentration is determined by water's total volume. Two different type of extracellular fluid modification are known: a) isotonic variations, in which both sodium and water vary; b) only sodium concentration changes (hyponatremia or hypernatremia). The most important causes of extracellular fluid fall are due to a reduced intake or to a fluid loss increase.

Burn injury impairs skin lipoproteins; this cause water loss through burn wounds, followed by hyperosmolarity, haemoconcentration and the tendency to withdraw fluids from the vascular bed. Moreover capillary permeability modification (2, 11, 22) allows water, sodium and proteins migration from the extracellular compartment to the damaged tissues (3, 22, 23). Haemoconcentration brings about a reduction in cardiac output, circulatory insufficiency, reduction of the cellular membrane potential with a further water and sodium withdraw, extracellular fluids and sodium reduction, hypoxia and cellular damage (2).

The main aim of fluid resuscitation in burned patients is to reduce haemoconcentration, maintaining

an high sodium concentration in the extracellular compartment (1, 9, 17, 24). All resuscitation formulas employ saline solution (18, 21, 22), but the total amount infused is different (7, 8, 10). Some protocols emphasize the total fluid amount that must be infused (RLS) (1, 4, 14), while others, on the other hand, point out only the total sodium that must be given (HLS) (2, 15, 16, 17).

Our data emphasize that the two different reanimation formulas utilized (RLS, with 132 mEq/l, and HLS with 215mEq/l sodium concentration) deliver essentially the same sodium load, but in significantly different concentration, total fluid volume and timing. The overall result was a same quality resuscitation in both groups, but with a significantly lower fluid load administered in HLS patients. Nevertheless there are not significant differences in urine volume and haematocrit between the two groups. In HLS patients an higher sodium concentration in the first 24 hours after burn was noted, and this, in our opinion could justify the hypokalemia present in the same period, too. In fact high sodium load produces a decrease in aldosterone excretion, resulting in sodium tubular reabsorption reduction, decreasing potassium migration in the extracellular compartment. In this group also a metabolic alkalosis occurred, but without significance difference with the other patients. We suppose that the reason could be related to the high concentration of sodium bicarbonate, (140 mEq/l) in HLS (Figure 9).

HLS administration improves the capillary osmotic pressure which tends to withdraw water from the cells into the functional extracellular fluid, thus reducing tissue oedema and complication rate especially in patients with pre-existing diseases (8, 19, 20, 24). Higher mortality rate in HLS patients was in our opinion due, to higher Roi index in respect to RLS group ($p < 0.05$).

It has to be pointed out that complication rate was lower in HLS than in RLS patients, with or without pre-existing diseases.

In conclusion fluid resuscitation to prevent burn shock using hypertonic lactated saline solutions, guarantees, in the first 48 hours after burn, a good electrolyte balance with fewer complications, even if more careful monitoring is requested (1, 19, 21, 22, 24).

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EMERGENCY TREATMENT AND EARLY FLUID RESUSCITATION FOLLOWING ELECTRICAL INJURIES

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SUMMARY

Injuries caused by high-tension electrical current are rare, but pathophysiologically unique with destructive effects. As a form of thermal trauma, electrical injuries represent a connection of skin burns and deep tissue destruction unpredictable in its depth which mostly resembles a crush injury.

Emergency treatment measures begin with the separation from the electrical contact if any and prompt transport to the nearest institution with all means for cardiorespiratory resuscitation and complete recovery. Resuscitation of the patient after electric shock continues then with fluid replacement using special formula modified for such cases, correction of acidosis and myoglobinuria and finally with escharotomy and fasciotomy which is most often necessary.

ZUSAMMENFASSUNG

Die urgente Behandlung und die frühe Flüssigkeitsresuscitation bei Verletzungen mit elektrischem Strom

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Die Verletzungen, die durch elektrische Hochspannung verursacht werden, sind zwar selten, aber durch ihre destruktiven Auswirkungen sind sie pathophysiologisch bedeutend. Als eine Form des termalen Traumas repräsentiert die elektrische Verletzung eine Verbindung der verbrannten Haut und der Destruktion des Tiefgewebes, dessen Tiefe man nicht voraussagen kann. Meistens erinnert die Verletzung an ein zerquetschtes Gewebe.

Die unaufschiebbare Behandlung beginnt mit Trennung des Verletzten von elektrischem Strom (der Kontakt wird aufgelöst) und dann folgt der urgente Transport ins nächste Krankenhaus, in dem sich eine Station zur kardiopulmonalen Resuscitation befindet, und in dem eine komplexe Behandlung garantiert ist. Die Resuscitation des Patienten nach dem elektrischen Schock erfolgt durch den Ersatz von Flüssigkeit nach einer speziellen modifizierten Formel für diese Fälle, Korrektur der Azidose und der Myoglobinurie. Die Escharatonie und die Fasziotomie sind unbedingt.

Key words: electrical injuries, resuscitation, fluid replacement, fasciotomy

Injuries caused by the electrical power are rare, pathophysiologically unique and have destructive effects. Those injuries are considered a particular field of thermal traumas. Related to the other types of thermal injuries, electrical burn injuries are considered specific due to extreme heat generated by a tissue resistance during electricity flow and unpredictable flow path through a body, as well as specific reaction of certain tissues.

Being unique and destructive form of a thermal trauma, electrical trauma represents a connection of skin burns and of deep tissue destruction unpredictable in its deepness and form. Because of progressive tissue necrosis, mostly it looks like a crush injury.

Concerning diagnostics, most of physicians are ready to call an electrical injury - an electrical

burn. In most cases, when body is in connection with the electrical power, a burn is caused. However, part of electrical injury is caused during flow of electricity through deep tissues where much serious damages than a skin burns are caused. This is the reason that an electric injury affects muscles and is followed with the presence of great myoglobin quantities in urine. Similar to it, an electrical injury penetrates into deep tissue causing muscular destruction and is followed with the presence of great myoglobin pigment quantities in urine and with acute tubular insufficiency. Sometimes it is possible to see an electric injury of the extremities that looks like a burn and is treated that way, while underneath a clostridial myositis is developing in two or three days period. Already dead tissues, skin and muscles, enable penetration of the microorganisms and de-

velopment of a destructive clostridial infection (Figs. 1, 2).



Fig. 1.



Figs. 1, 2: Passage of the high-tension electric current over the flexor surfaces from radiocarpal joint to the axilla.

All those facts are pointing out the serenity of the problem we are facing in the century which makes impossible to imagine life without electricity. Electrical power is constantly surrounding us in appearing in different electrical devices in the house, in the offices, even in nature. Increasing industrialization and technological development, as well as the life standard improvement enabled most of the people to use electrical devices. In the past few decades this affected the increase of injuries and fatal results caused by the electric power. On the other side, improvement of a security measures, general education and constant anti hazard warnings against electroinduction represent positive facts in keeping the number of injuries below the level that should be expected.

Those injuries are mainly present in the young population facing the most productive life period and very often they result, if not with fatal end, then with severe and permanent invalidity followed by great economical and social consequences.

TREATMENT

1. Initial Treatment

Initial treatment of an injured person depends upon the type of electrical burning injury. If it is electrocution, separation of the injured person from the contact with electrical power is the first measure to be taken in such situations. Persons involved in this procedure, e. g., rescuers, need to be well-isolated themselves in order to avoid electrical shock during attempting to separate the injured person. If this operation is successfully completed, an urgent evaluation of cardiorespiratory status of the injured person is to be taken as well as resuscitation measures like ventilation with external heart compression, in case of heart failure. Most survivors begin to breathe spontaneously in 30 minutes, while complete recovery needs continuation of resuscitation measures for at least four hours more. Transportation in the nearest specialized health institution, e.g., an intensive care department, has to be organized in proper way and as soon as possible.

Cardiorespiratory problems of the patient injured with electricity are either fatal or not noticeable after the time of reaching a hospital, but is necessary to continue with monitoring. In this moment, however, it should proceed with an urgent and adequate shock treatment and prevention the of strong ischaemia consequences that appears after sudden swelling, specially on extremities.

1.1. Resuscitation of the Patient After Electrical Shock

Consequence of injury caused by electrical power is sudden, almost immediate lost of body fluids in the area of a damaged tissue and consequent release into myoglobin from damaged muscular cells of circulation. Small quantities of haemoglobin produced by erythrocyte destruction are released as well as other intercellular substances which cause heavy metabolic acidosis. Fast application of a special therapy for any of mentioned abnormalities is helping in decreasing electrical injury complications which are numerous in the first stage.

1.1.1. Fluid Replacement

Fluid replacement is the most important aspect of the initial resuscitation of the electrically injured patient. Patients with conventional thermal injuries, e.g. burns should replace a quantity of fluids that is easy to calculate if using some of the already known formulas by means of calculating body weight and percentage of the TBSA (Evans, Brook, Parkland formula).

However, unpredictable extensiveness and deepness of tissue damages are the factors that make more difficult evaluation of the lost fluids. In such situation percentage of the burned surface cannot be an indicator for the quantity of fluid which should be replaced. Some authors are

recommending the increasing of this quantity three times if the burned skin surface is below 20% of the TBSA. It should be increased twice or even less considering increasing of a burned skin percentage. According to this, patient with upper extremity electrical burn needs 7 - 8 liters of fluids per day in order to get adequate reanimation. Anyway, taking into account that a surface of a burned skin cannot be an adequate parameter for evaluation of a lost fluids, it is considered that the most important is fast fluid replacement until a stable urinary output of 50-100 ml per hour is achieved. It is necessary to maintain the urinary output achieved in this way. The isotonic balanced saline solution such as Ringer-lactate is the ideal solution because intercellular fluid, that is the most similar, represents the most part of the lost fluids.

As in any other process of a patient reanimation process, a permanent monitoring is necessary as well as constant measurement of urinary output per hour, haematocrit, osmolality of plasma and a central venous pressure. Diuresis of 50-100 ml/h and gradually decreasing of haematocrit are usually the signs of an adequate fluid replacement.

Sometimes it is not possible to make a precise calculation of the fluid quantities needed for adequate resuscitation. That is the consequence of an inadequate primary treatment in the health institution that is having the first contact with the patients or because not keeping a precise evidence of the given fluids. Despite of those problems, we succeeded to establish some kind of protocol for fluid replacement at those patients:

- * A fluid replacement should start according to Parkland's formula increased two or three times depending on the surface of electrical injury (three times if the surface is 20% and twice or less according to the increasing percentage of a burned skin)

- * In the first 24 hours exclusively crystalloids should be used as well as energetically important hypertony solutions with constant checking of a serum sodium that should be maintained between 145 and 160 meq/l.

- * Alternative hyperbaric oxygen therapy should start as soon as possible, e.g., immediately after completing the initial treatment.

- * Intensive use of hypertony crystalloid solutions gives a possibility of using colloids (4-20% albumins, fresh frozen plasma) in the first 18-24 h after injury. Hyperbaric oxygen with its vasoconstrictive effects decreases protein loss.

- * Fluids replacement should be intensified, if necessary for the stimulation of diuresis that should be 50 - 100 ml/h and with the control of the color of urine because of the presence of haemachromogens.

- * In case of myoglobin appearance some instant measures should be taken giving great quantities of fluids and osmotic diuretics, choosing mannitol preferably.

- * To exclude threatening hyperkalemia after 24 h a constant potassium control should be maintained as well as control of sodium, urea and creatinine.

- * After peristaltic appearance during second day it should be started with nasogastric hyperalimentation.

- * Blood transfusion may be used starting second or third day.

- * Taking of vitamin C (500-1000 mg per day) is a contribution for the wounds healing.

1.1.2. Acidosis

With electrical injuries the fall of blood pH is much bigger than with purely thermal injuries, e.g., burns. This is the result of great quantity of acid disintegration products from devascularized and devitalized tissues. Blood pH fall cannot be in correlation with injury extensiveness because blood vessel thrombosis often stop the comeback of acid products into circulation system. Patients having electrical injuries with 10 - 20 % TBSA and not having big blood vessels' thrombosis, often have arterial pH between 7,20 and 7,24 in the first few hours after being injured and having thrombosis of big blood vessels can have arterial blood pH within the normal limits.

More than half of patients suffering mioglobinuria face extreme acidosis that makes reanimation process more complicated. For the proper treatment of this actual or potential problem arterial blood should be constantly checked to pH, pO₂ and pCO₂. Correlation of acidosis demands a special alkalized therapy. 100-300 mEq of sodium bicarbonate should be included in the first 2-3 liters of fluid as a prevention of further blood pH fall. It should be constantly kept under control.

A further phase requires doses of 80 - 120 ml of sodium bicarbonate to keep and achieve stabilization of pH at acceptable level, e.g., above 7,35. A total quantity of sodium bicarbonate needed for a complete stabilization of acidity is individually variable. Considering that most of the patients having tissue destruction show the signs of acidosis, the usage of sodium bicarbonate as an early treatment is the right preventive therapeutical approach.

1.1.3. Mioglobinuria

Myoglobin presence in urine is not rare in patients who have significant electrical injuries. Its value can reach up to 6 gr. on 100 ml. This is representing a sign of massive muscle destruction. The greatest part of pigment excretion is myoglobin. The haemoglobin can be noticed in very small quantities representing a destruction of red blood cells. Presence of coloured urine, with color variation from red to black despite of relatively good diuresis (> 50 ml), is a reliable sign of massive muscle destruction. At C. Baxter's serial, all the patients that suffered mioglobinuria over six hours had to have either an amputation of one or more extremities or extensive necrectomy.

The hemohromogen appearance in urine demands a special treatment in order to prevent tubular insufficiency development as a result of pigment excretion in the presence of hypovolemia and acidosis. Therapy consists of great quantities of fluids and osmotic diuretics and manitol is the diuretic of choice. Depending on an author, the concentrated doses may be applied for a short period (initial dose of 25 g, than 12,5 g per hour in the period of few hours, results usually with diuresis of 200 - 300 ml/h - according to Baxter or even smaller doses of 5 - 20 mg/h for several days).

Mioglobinuria that is maintained several hours, even several days, after having an adequate fluid replacement, as already has been stated, is a sign of a great muscles destruction. In those cases an early amputation or extensive necrectomy represents the only safe choice. Permanent monitoring of arterial blood pH is obligatory because hemohromogens are giving paradoxical alkaline urine that cannot be the criterion for therapeutical decisions.

1.2. Escharotomy and Fasciotomy

Fasciotomy has therapeutical and diagnostic role in the treatment of electrical injuries. An intensive swelling of injured extremity, usually present at the beginning and during first several hours, obviously gives a first indication for fasciotomy in order to normalize a blood flow. Impaired circulation distal from the injured area represents a big therapeutical problem. It can be the result of a constrictive effects of the strong eschar that circumferently takes full skin thickness (Fig. 3).



Fig. 3: Fasciotomy after electrical injury of the upper extremity.

It can also be the result of compressive effect of venous obstruction and/or subfascial oedema of the swollen muscles. It is very difficult to achieve a complete certainty of etiology of distal vascular collapse during electrical injury of an extremity. It is specially difficult in a situation when the injury is combined also with a flame burn. In case

of impaired circulation the adequate, prompt and full treatment is necessary. After removal of a solid eschar if there is still no expected blood flow, a fasciotomy is indicated if manifested by swallowed, oedematous muscles under the fascia. If there is even any sign that a subfacial swelling is a cause of an impaired circulation then we have a definitive indication of fasciotomy. The muscles' appearance which is to be expected is going to give us an answer about an amputation necessity. However, in that moment, it is not definitively a reliable factor because a progressive arterial and venous thrombosis can provoke a muscular necrosis in a period 2 - 3 weeks after being injured. This is pointing out the problem of an early necrotomy in electrical injury cases (Fig. 4).



Fig. 4. Extensive muscle necrosis of the forearm following high-tension electrical injury.

Even in cases of extreme carbonification when the necessity for amputation is obvious, an initial fasciotomy will enable the lowest possible level of amputation. On the other hand, with patients who have minimal surface swelling very often the heaviness of injury can be overlooked. Careful fasciotomy of certain muscles' compartments can lead us to their swelling even in cases when skin is not hard and swelled enough to point out a fasciotomy necessity.

Fasciotomy can be very important in determining the area and extensiveness of necrotic muscular masses. If those necrotic masses remain unnoticed, in a period of 3 - 5 days they become toxic, susceptible to liquefaction and abscesses formation that leads to sepsis. Muscular damage can sometimes be limited to only one group of extremities while in a further development muscular necrosis may spread selectively either into deep or superficial muscles of the one or several compartments.

An adequate fasciotomy requires a skin and subcutaneous incision as well as incision of all muscular groups. Still it is not a guaranty for survival of damaged muscular masses because intravascular thrombosis during the first two weeks may only postpone the indicative signs of

muscular necrosis. An adequate fasciotomy should be performed promptly before ischaemic changes become irreversible. In cases where a significant hand swelling is present, especially if medianus nerve is involved, a separation of the volar carpal ligament is performed. After fasciotomy, exposed tissues are covered with protective biological materials.

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EXPERIENCE WITH THE MODIFIED MEEK TECHNIQUE

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SUMMARY

In 1958 Meek described the so called Meek - Wall dermatome to cut postage stamp skin grafts. This method was eclipsed by the introduction of mesh skin grafts. In 1993 Kreis and colleagues reintroduced a modified Meek technique using a dermatome running on compressed air. This technique has been used in our burn unit since August 1994. The aim of this paper is to compare the modified Meek technique with the mesh graft technique.

Within a period of 20 months 41 patients were grafted using the modified Meek technique. The mean TBSAB was 54.4% with 50.0% full thickness burns. All patients were excised early. The expansion ratio was 1:4 and 1:6. In 20 patients the Meek technique was used exclusively for grafting of the trunk and the extremities with the exception of face, neck and hands. In 3 patients with a mean TBSAB of 68.3% a combination of postage stamp autologous skin grafts and cultured epithelial autografts (CEA) was applied.

Compared with the mesh graft technique the Meek technique showed the following advantages: 1. The Meek method provides the true expansion ratio. 2. Small graft remnants can be utilized. 3. Grafting of full thickness burns up to 70 to 75 % TBSAB becomes possible with one harvest of the donor sites. 4. The reliability of graft take is equal or better. 5. Epithelialization is achieved within 3 to 4 weeks depending on the expansion ratio. 6. The combination of widely expanded postage stamp split thickness grafts and CEA provides an excellent take rate and durable wound closure within a short time and avoids the problems associated with the engraftment of CEA on fascia.

The method is simple but more demanding than the mesh technique. Compared with the mesh graft technique the preparation of Meek grafts is more time consuming and requires more staff than the Mesh technique. The cost of materials is higher.

In our experience complete coverage of the Meek grafts with an overlay of meshed allografts after removal of the gauze as recommended by Kreis is not necessary using the 1:4 expansion ratio. Greater expansion ratios necessitate an overlay with meshed allografts. Regarding the scar formation no significant differences were observed compared with the mesh graft technique.

In conclusion the modified Meek technique is reliable and simple to perform. This technique provides a sufficient expansion ratio enabling to graft patients with burns up to 75% TBSA with only one harvest of donor sites and without the necessity of CEA. In our opinion the Meek technique is reliable and simple to perform. This technique provides a sufficient expansion ratio enabling to graft patients with burns up to 75% TBSA with only one harvest of donor sites and without the necessity of CEA. In our opinion the Meek technique is advantageous in patients with burns greater than 45% TBSAB. In smaller burns mesh grafts should be used because of lower material cost and staff requirements. Especially in extensively burned patients the Meek technique may be cost effective avoiding the need of CEA.

ZUSAMMENFASSUNG

Erfahrungen mit der modifizierten Meek Technik

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Einleitung: 1958 beschrieb C. P. Meek das sogenannte Meek - Wall Dermatom zur Herstellung briefmarkenähnlicher kleiner Hauttransplantate. Diese Methode geriet nach Einführung der Mesh graft Technik in Vergessenheit. Erst 1993 wurde sie von Kreis et al. wieder in die Verbrennungschirurgie eingeführt. Dabei wurde ein modifiziertes Dermatom verwendet, das mit Pressluft betrieben wird. In unserem Verbrennungszentrum wird die modifizierte Meek Technik seit August 1994 eingesetzt. Unsere Erfahrungen mit dieser Technik werden beschrieben.

Patienten und Methoden: In 20 Monaten wurden bei 41 Patienten Hauttransplantationen mit der modifizierten Meek Technik durchgeführt. Die mittlere verbrannte Körperoberfläche lag bei 54,4% mit 50,0% III.° Verbrennungen. Alle Patienten wurden früh excidiert und danach sofort nach der Meek Methode transplantiert. Bei 20 Patienten wurde die Meek Technik ausschliesslich verwendet. Die Expansionsrate der Spalthaut war 1:4 oder 1:6. Bei drei Patienten mit einer durchschnittlichen Verbrennungsgrösse von 68,3% wurde eine Kombination aus Meek Transplantaten und kultivierter autologer Haut verwendet.

Ergebnisse: Insgesamt wurden bei 103 Operationen die Meek Technik angewendet. Bei vier Patienten wurde eine Expansionsrate von 1:6 verwendet. Bei allen anderen Patienten wurde die Spalthaut im Verhältnis 1:4 expandiert. Nach spätestens 7 Tagen hafteten die Transplantate fest auf dem Wundbett. Die durchschnittliche Einheilungsrate lag bei 91% und die Epithelisierungsrate bei 93%. Bei 8 Patienten wurden die Gazen 3 Wochen auf den Transplantaten belassen und danach eine gute Epithelisierung beobachtet. In diesen Fällen konnte auf eine Fremdhauttransplantation verzichtet werden. Bei 3 Patienten führte die Kombination aus Meek Transplantaten und autologer Kulturhaut zu Einheilungsraten von 90%. Bei allen Patienten wurden die Spenderstellen nur einmal benutzt. Ver-

gleichen mit der Mesh Technik zeigte die Meek Methode folgende Vorteile: 1. Die tatsächliche Expansionsrate wird erreicht. 2. Ungünstige Spenderstellen können genutzt werden. 3. Kleine Transplantatreste können noch verwendet werden. 4. Die Methode ist sehr zuverlässig. Nachteile sind die höheren Kosten, der grosse Zeitaufwand zur Herstellung der Transplantate und der höhere Personalbedarf.

Schlussfolgerung: Die Meek Technik ist zuverlässig und einfach. Der wichtigste Vorteil besteht darin, dass die tatsächliche Expansionsrate erreicht wird. Das ermöglicht die Transplantation von Patienten mit Verbrennungen bis zu 75% der Körperoberfläche, ohne die Spenderflächen mehrmals zu verwenden. Besonders bei Patienten mit ausgedehnten Verbrennungen kann die Meek Technik kultivierte autologe Haut überflüssig machen und so Kosten sparen.

Key words: burns, surgery, skin transplantation

Early burn wound excision and grafting have been shown to improve survival (1-5), decrease length of hospital stay (5-8) and reduce expenditure (5). However, in extensively burned patients the limited areas which can be used for donor-site harvesting still remain a crucial point. Even if harvesting is performed at as shallow depth as possible, there is a point at which any further recropping is of largely nonviable epithelium (9).

To resolve the problem of severely limited donor-sites, different strategies were developed. Promising developments of artificial skin substitutes have been reported recently (10-12). Reliable results have been obtained using cultured epithelial autografts (CEA) (13, 14) among patients with scarce donor-sites. However in most patients with major burns more traditional techniques are still in use. In cases lacking donor-sites, staged grafting of the excised areas with intermittent coverage of the remaining areas with cadaver skin may be performed. Other strategies are directed to the expansion of the available autologous skin to enable grafting of massive burn wounds (15-18).

Another technique to expand split thickness skin grafts is the modified Meek technique, reintroduced by Kreis (19) and colleagues in 1993. In 1958 Meek (20) described the so called Meek - Wall dermatome to cut postage stamp skin grafts. This method became eclipsed by the introduction of mesh skin grafts. Since 1994 a modified Meek dermatome running on compressed air is offered

by a Dutch company (Fig. 1). This dermatome has been in use in our burn unit since August 1994. In this paper, our clinical experience with the modified Meek technique is described.

PATIENTS AND METHODS

Within a period of 20 months 41 patients were grafted using the modified Meek technique. The technique is described below. The mean TBSAB was 54.4% (range 30.5% to 80%) with 50.0% (range 30% to 68%) full thickness burns. The patient characteristics are shown on Table 1. All patients were excised early. The full thickness burns were excised beginning on the first day after burn injury. Further excisions were performed every second day until the whole burned area requiring excision and grafting had been excised. The operations were limited to 20% to 30% total body surface area per procedure. The excised areas were grafted immediately with postage stamp skin grafts which were prepared using the modified Meek dermatome. The expansion ratio was 1:4 and 1:6. In 20 patients the Meek technique was used exclusively for grafting of the trunk and the extremities with the exception of face, neck and hands. In 3 other patients with full thickness burns of 68.3% total body surface area a combination of postage stamp autologous skin grafts and CEA was applied.

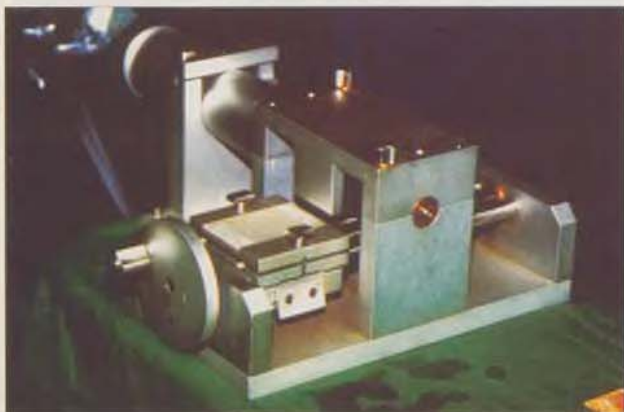


Fig. 1: The modified Meek dermatome.

Table 1: Patient characteristics.

		range
number of patients (no.)	41	
mean age (years)	35.7	15-81
TBSAB (%)	54.4	30.5-80
full thickness burn (%)	50.0	30-68
inhalation injury (no.)	17	

SURGICAL TECHNIQUE

At the beginning of the operation the extent of the excision was determined. Thereafter the esti-

mated amount of split thickness skin grafts was harvested required to graft the excised areas with postage stamp skin grafts at the end of the operation. The full thickness burns were excised down to fascia and complete hemostasis was performed. The skin grafts were prepared simultaneously using the modified Meek dermatome.

The split skin autografts are spread dermis side down on a cork square measuring 4.2 cm x 4.2 cm (Fig. 2). Then the cork with the split thickness skin is placed in the carrier block of the Meek dermatome and secured by a grill. The carrier block is passed through the dermatome which contains 13 parallel circular blades. The dermatome runs compressed air. The blades of the dermatome cut through the graft into, but not through the cork. After the first pass skin stripes of 3 mm in width are prepared (Fig. 3). Now the grill is removed and the cork with the graft is rotated 90°. Again the skin graft is secured with the grill and passed through the dermatome once more. Thereafter the graft is cut in 14x14 small squares measuring 3 mm x 3 mm (Fig. 4).

After removal of the cork from the carrier block the upper side of the graft is sprayed with

an adhesive dressing spray. The spray needs about two minutes to become sticky. Then a pre-folded gauze which is folded on an aluminium foil is pressed onto the grafts for a few seconds. Thereafter the cork is removed leaving the graft islands adhering to the gauze (Fig. 5). The gauze is pulled out on all four sides until the gauze becomes completely unfolded (Fig. 6). The aluminium foil can be peeled off.

After trimming the margins of the gauze with the adhering postage stamp skin islands grafting can be performed. The gauze is applied graft side down on the wound bed and fixed with staples (Fig. 7). After 6 or 7 days the gauzes are gently removed leaving the graft islands on the wound bed. The grafts are covered with an overlay of glycerol preserved meshed allografts (Fig. 8). The allografts meshed 1:1.5 are secured with staples. Dressings are performed using vaseline gauze. The dressings are changed for the first time four days after grafting of the postage stamp skin islands. After removal of the gauzes and grafting of the allografts, dressing changes are performed every second day until epithelialization is complete.



Fig. 2: The split skin grafts is spread dermis side down on the cork square.

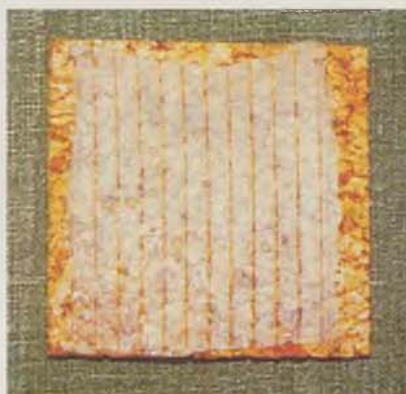


Fig. 3: After the first pass through the dermatome skin stripes of 3 mm in width are prepared.



Fig. 4: After the second pass through the dermatome the graft is cut in 10x10 small squares measuring 3 mm x 3 mm.



Fig. 5: The cork is removed leaving the graft islands adhering to the gauze.



Fig. 6: The gauze is pulled out on all four sides until the gauze becomes completely unfolded.



Fig. 7: The gauze is applied graft side down on the wound bed and fixed with staples.



Fig. 8: Five days after coverage of the grafts with an overlay of glycerol preserved meshed allografts.



Fig. 9: The result 5 weeks after grafting.

RESULTS

In most of 41 patients Meek grafts with an expansion ratio of 1:4 were used. In four patients an expansion ratio of 1:6 was used. In all patients it was able to graft all excised areas with only one harvest of donor sites. The skin islands firmly adhered to the wound bed at the latest seven days after grafting. Overall 103 grafting procedures were performed. The mean take rate after removal of the gauzes amounted to 91%

(range 45% - 100%). Epithelialization was completed after about three to five weeks depending on the expansion ratio (Fig. 9). The observed rate of epithelialization was 93%.

In one patient we forgot to remove one gauze with an expansion ratio of 1:6. When the gauze was removed approximately three weeks after grafting epithelialization could be observed under the gauze. We tried to take advantage of this finding in patients grafted with an expansion ratio of 1:4. In eight patients the gauzes were left on the wound bed for three weeks. After removal of the gauzes epithelialization was observed and the application of allografts was unnecessary. In another two patients removal of the gauzes became necessary after ten days because of evidence of wound infection. In these patients epithelialization was reached using glycerol preserved allografts.

In three patients a combination of widely expanded postage stamp split thickness grafts and CEA was used. The widely expanded Meek grafts were grafted within the first week after injury. Further treatment followed according to standard protocol. Seventeen days after injury the allografts were removed and the remaining postage stamp skin islands were overlaid with CEA. The combination provided an excellent take rate (mean 90%) and durable wound closure within a short time and also avoided the problems associated with the engraftment of CEA on fascia.

Compared with the mesh graft technique the preparation of Meek grafts is more time consuming and requires more staff. In our experience it is favourable to harvest the split thickness skin at the beginning of the operation and to prepare the Meek grafts simultaneously with the excision of the burn eschar. Three additional staff are necessary to perform the preparation of the Meek grafts during excision time. Only in this way it is possible to prepare sufficient grafts so that at the end of excision grafting can take place without delay. Compared with the mesh graft technique cost of materials of the Meek technique is higher.

DISCUSSION

The results demonstrate that the Meek technique using an expansion ratio of 1:4 and 1:6 represents a reliable method to enable wound healing in extensively burned patients. In all patients it was possible to complete grafting of the excised burn wounds with one harvest of the donor sites. In our experience providing the true expansion ratio is the most important advantage of the Meek method. In patients with massive burns unfavourable donor site can be harvested and small graft remnants can be utilised. In contrast to the Meek technique it has been demonstrated that the expansion rate of meshed skin is significantly less than expected (21). Small graft remnants are not suited to prepare widely expanded mesh grafts. Furthermore the distribution of the post-

age stamp skin grafts on the wound surface seems to be more efficient when compared with mesh grafts (19).

On the other hand mesh grafts are easy to prepare requiring less staff than the Meek technique. The material cost are lower. Therefore mesh grafts are used by us in patients with suitable donor sites. In our experience the Meek technique is advantageous in patients with burns greater than 40% to 45% and enables grafting of full thickness burns up to 70 to 75% TBSAB. Especially in extensively burned patients the Meek technique may be cost effective avoiding the need of CEA.

We have used a combination of widely expanded postage stamp split thickness grafts and CEA. The results were favourable and comparable to the results observed in our patients grafted with CEA using the technique of Cuono (22). But the durability of wound closure seemed better in the patient with the combination of Meek skin grafts and CEA. In other patients epithelialization could be reached without utilising allografts. This technique failed when wound infection occurred. Further experience is necessary. In our experience Meek skin grafts in combination with an allograft overlay remains the standard technique.

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SKIN EXPANSION IN BURN SEQUELAE: RESULTS AND COMPLICATIONS

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SUMMARY

Before Radovan introduced skin expansion, burn sequelae were treated with skin grafts, local or distant flap, with an high morbidity on the donor site. Actually this technique is well known and standardized procedure that allows to obtain local flaps with the same characteristics in colour, texture, hair and sensitivity of the normal skin.

The authors analyze their experience in the treatment of burn sequelae from 1985 to 1995. During this period, 157 patients underwent surgery to correct burn scars and contracture, utilizing 262 skin expanders.

The implants were positioned on the fascial layer; antibiotic and drainage were routinely used. The inflation of the expander began 2 weeks after surgery, and hyperexpansion was the rule, when possible.

Only in 6.4% (10 patients) expansion failed, while in the remaining cases good partial (in patients with too large scars) or total results were achieved.

Complication rate in skin expansion is high. In this series complication occurred in 73 of 262 expansion, but 43 were easily solved. So only in 30 expansions the final outcome was influenced by complication, with higher incidence in neck and in lower extremities.

Results were generally satisfactory, with an improvement of scars and minimal donor site morbidity. With a careful selection of the patients, skin expansion offers a good solution for burn sequelae, complications can be reduced and successful results achieved.

ZUSAMMENFASSUNG

Die Hautexpansion bei den Verbrennungsfolgen. Die Ergebnisse und Komplikationen.

M. Governa, A. Bortolani, D. Beghini, D. Barisoni

Vor der Einführung der Hautexpansion durch Radovan, wurden die Verbrennungsdefekte mit lokalen oder entfernten Lappen behandelt, und zwar mit einer hohen Komplikationerrate an der Entnahmestelle. Gegenwärtig repräsentiert diese Technik eine Standardmethode, die eine Gewinnung derselben gleichartigen Hautlappen von ähnlicher Farbe, Struktur, Empfindlichkeit und Behaarung, die einer normalen Haut entsprechen, ermöglicht.

Die Autoren analysieren ihre Erfahrungen in der Behandlung der Verbrennungsfolgen von 1985 bis 1995. Während dieser Zeit erfolgten bei 157 Patienten chirurgische Korrekturen der Verbrennungsnarben und Kontrakturen. Bei diesen Eingriffen wurden 262 „Hautexpandere“ angewandt. Die Implantate wurden an die Faszia angelegt, mit regelmäßiger Anwendung von Antibiotika und einer Drainage. Die Inflation des Expanders begann 2 Wochen nach dem chirurgischen Eingriff und wenn es möglich war, wurde er regelmäßig hyperexpandiert. Die Expansion versagte nur bei 6,4 % (10 Patienten), wogegen bei den übrigen Fällen partielle gute (bei den Patienten mit übermäßig ausgedehnten Narben) oder totale Ergebnisse erreicht wurden. Nach der Hautexpansion bestand eine hohe Komplikationsrate. Von den 262 Expansionen bestanden Komplikationen in 73 Fällen, jedoch bei 43 Patienten wurden sie leicht beseitigt. Das Endergebnis wurde nur in 30 Fällen durch die Komplikationen beeinflusst, insbesondere in der Gegend des Halses und der unteren Extremitäten. Die Ergebnisse sind im allgemeinen befriedigend, mit Verbesserung der Narben und der Herabsetzung der Komplikationen an der Entnahmestelle. Bei den gelegenen Patienten leistet die Hautexpansion eine befriedigende Methode mit Beschränkung der Komplikationen und Erreichung von guten Ergebnissen.

Key words: skin expansion in burns

For many years burn scars have been traditionally treated with surgical excision and coverage with split or full thickness skin grafts, local flaps and, when these procedures were not possible, with distant flaps (5, 6, 7, 22).

All these surgical treatment, that represent the history of the reconstructive surgery, were not

always safe, often uncomfortable for the patients and, sometimes, unsatisfactory.

In the first 80s, Austad, Radovan and other surgeons revolutionized this branch of plastic surgery introducing soft tissue expansion, opening a new and interesting chapter of burn scar's surgical treatment (2, 4, 9, 19, 26, 27). In fact since

then, skin expansion has become one of the most known and utilized method in following burn and trauma reconstructions. It offers many advantages over previous surgical modalities (skin color and texture), but mainly it avoids the need for transfer of distant flaps without introducing new scars in the donor sites (6, 16, 18).

We present here our clinical experience in the use of expanders to resurface burn scarred areas and release contracture in head and neck, trunk and extremities.

MATERIAL AND METHODS

We report about 157 patients admitted and treated with tissue expansion for burn scars release in the period from 1985 to 1995 in our department.

There were 106 females (67.5%) and 51 males (32.5%), with an average age of 26.2 years (Table 1). Two hundred and sixty two skin expanders (70% of which with remote port valve), were totally used (Table 2).

More than one skin expander was introduced in 65 patients, and 35 of them underwent to expansion in more areas simultaneously.

Skin expanders were positioned subcutaneously above the fascial layer, and sometimes under the muscle (e.g., in the forehead or in anterior neck area), or under the fascia, such as the galea capitis in the scalp.

Two patients had a free flap raised in the expanded area (parascapular free flap), and in three patients a full thickness skin graft, for resurfacing face or neck, from groin and abdominal expanded skin was obtained.

The incision was initially performed on the edge of the lesion; later on, according with the literature data, it was placed in a distant position (24, 29, 30), and, when possible, in scar areas avoiding to add a new scar in the skin adjacent to the defect. Suction drains was always used and maintained until the drainage was minimal. Prophylactic antibiotic therapy was routinely used for some days after surgery.

Table 1: Patients, sex and average age.

patients	157
males	51 (32.5%)
females	106 (67.5%)
average age	26.2 years

Table 2: Patients, expanded areas and number of skin expanders utilized.

SITE	PATIENTS	EXPANDERS
head and neck	77	128
trunk	38	67
upper limb	15	24
lower limb	27	43
total	157	262

Expansion normally began about 15 days after surgery, and it was weekly repeated. Hyperexpansion was the rule when possible. Sometimes handly capsulotomy was performed, to break the capsule forming around the expander: this procedure allowed further filling and minimize pain during the inflation.

Only in the early years the periprosthetic capsule was removed, releaving the skin expander; in the following period it was only incised to lenghtening the expanded flap (21).

RESULTS AND COMPLICATIONS

In the evaluation of the clinical result we considered a good and complete results if reconstruction was accomplished as planned.

In 98 patients (62.4%) a full up scar resurfacing and release was achieved and only in 10 patients (6.4%) skin expansion failed with a poor result (Table 3). Necrosis of the expanded flap interested scalp in one case, neck in two patients and supraclavicular region that was expanded for a severe neck contraction in the last case.

Four infection with early extrusion of the implant occurred: two in the limbs (in the wrist and in calf region) and two in the neck.

Dislocation of the remote injection port was present in a patient with a big expander positioned in the lower abdomen for chest correction; the complication requested surgical removal of the implant with a poor result. The last failure was due to a wide haematoma in the neck: in this case also, the prosthesis was removed and the patient was treated with a skin graft during the same operation.

In the remaining 49 patients (31.2%), a partial result was obtained, but in 32 of them (65.3%) this was due to a too large defect.

Only in 17 remaining patients the final outcome was influenced by complications (Table 3).

According with Manders and Coll. (19), major and minor complications were distinguished: the first can make fail the expansion, the latter can be solved, without failure of the surgical procedure.

Major complications

- **Skin necrosis:** it was noted in 6 expansions (4 Patients).

- **Infection with the extrusion of the prosthesis:** this complication was more frequent in head and neck; nevertheless it was possible to achieved a good partial result in 14 expansions, while the expansion failed in other four.

- **Expander or remote port injection rupture or dislocation:** four expansion failed for this type of complication (3 Patients, in one of which the expansion must be stopped). In the latter two patients rupture occurred close to the end of the expansion period, so that a partial result was obtained.

Table 3: Results obtained in 157 patients treated with skin expansion for burn scars (262 expansions).

RESULT	EXPANDED AREAS				
	Head and Neck	Trunk	Upper Limb	Lower Limb	Total
Good	51/77 (66.2%)	23/38 (60.5%)	7/15 (46.6%)	17/27 (63%)	98/157 (62.4%)
Partial	21/77 (27.3%)	12/38 (31.6%)	7/15 (46.6%)	9/27 (33.3%)	49/157 (31.2%)
*too big defect	13/21 (61.9%)	8/12 (66.7%)	5/7 (71.4%)	6/9 (66.7%)	32/49 (65.3%)
*complication	8/21 (38.1%)	4/12 (33.3%)	2/7 (28.6%)	3/9 (33.3%)	17/49 (34.7%)
Failure	5/77 (6.5%)	3/38 (7.9%)	1/15 (6.6%)	1/27 (3.7%)	10/157 (6.4%)
Total	77	38	15	27	157

Table 4: Total complications occurred in 262 expansions (157 patients).

	EXPANDED AREAS				
	Head and Neck	Trunk	Upper limb	Lower Limb	Total
N° Expanders	128	67	24	43	262
Infection/extrusion	14/128	2/67	1/24	1/43	18/262
Expander/valve rupture or dislocation	1/128	1/67	1/24	1/43	4/262
Skin sufference	5/128	2/67	1/24	2/43	10/262
Skin necrosis	2/128	2/67	-	2/43	6/262
Local infection	8/128	1/67	-	-	9/262
Haematoma	4/128	2/67	-	1/43	7/262
Syeroma	4/128	1/67	1/24	2/43	8/262
Deihescence	3/128	-	1/24	1/43	5/262
Pain	4/128	-	1/24	1/43	6/262
Total	45/128	11/67	6/24	11/43	73/262

• **Haematoma:** in one case a big haematoma occurred, requiring the prosthesis removal, with additional surgery, and the patients refused another expansion programme. In the remaining 6 patients this complication was easily solved without interruption of the treatment (Table 4).

Minor complications

• **Local infection:** there were 9 cases of local infection; all were solved with antibiotics, topical treatment and deflation of the expander. Some days later, when the clinical appearance showed a good situation in the expanded area, the inflation programme was continued, without influencing the planned result.

• **Seroma:** was noted in 8 expansions; the suction drain was maintained for some more days.

• **Deihescence:** 5 cases in this serie, was solved with a new suture some days later.

• **Transitory skin sufference:** never represented a severe complication. It occurred in 10 cases and was always solved without any further surgical procedure.

• **Pain:** it was described by patients in 6 expansions, but only in one of them it influenced the final outcome. Normally pain can be eliminated with slow inflation or, sometimes, with a manual capsulotomy to break the capsule and release the expander (Table 4).

Totally the patients in this study presented 73 complications in 262 expansions, 43 of those could be solved without additional surgery (Table 5).

Table 5: Complications solved without influencing the final outcome.

	EXPANDED AREAS				
	Head and Neck	Trunk	Upper limb	Lower Limb	Total
N° Expanders	128	67	24	43	262
Local Infection	8/128	1/67	-	-	9/262
Haematoma	3/128	2/67	-	1/43	6/262
Syeroma	4/128	2/67	1/24	1/43	8/262
Deihescence	3/128	-	1/24	1/43	5/262
Skin Sufference	5/128	2/67	1/24	2/43	10/262
Pain	3/128	-	1/24	1/43	5/262
Total	26/128	7/67	4/24	6/43	43/262

DISCUSSION

Skin expansion has offered to plastic surgeons a new answer to the problem of insufficient local tissue for burn scar correction. In fact the main indication for this reconstructive procedure is to provide an increase amount of healthy skin close to the lesion such as to permit reconstruction and primary skin closure.

Before Radovan introduced this technique, the patients must be treated with a wide variety of skin grafts, local or distant flaps that were often uncomfortable for the patients, not so safe and appreciable on a cosmetic point of view.

Actually tissue expansion represent a well known and standardized procedure, it can be repeated to obtain large local flaps with very close characteristics in colour, texture, hair and sensitivity to the original skin (1, 10, 12, 15). This is particularly useful for scalp, face and neck, where the final result is frequently far superior to that obtained by alternative means of reconstruction.

Agreed with other authors (3), we preferred rectangular or longitudinally curved expanders, because the gain in skin obtained with this shape is greater than others.

In our series none of the patients referred subjective disturbance of sensitivity after the removal of the implant.

Failure was observed in 10 of 157 patients. The most frequent site of failure were neck and lower extremities, while none happened in the face area.

It is interest to consider that complications very often did not compromise the final outcome, because they occurred often close to the end of the expansion period. Furthermore it must be emphasized that failures and complications occurred in the early years of skin expansion's utilization.

The total amount of complications, as described by many authors must be critically considered. In fact only few mayor complications can compromise surgical procedure, meanwhile the great part of them may slow down the expansion programme, but don't influence the final outcome (19, 20, 23).

In this series the total complication rate was high, 73/262 (27.9%), but a lot of them, 43/73, were minor complications, and could be easily solved without problems. So, only 30 of 73 total complications influenced the final outcome (Table 6).

Table 6: Total complication rate, minor solved and influencing the final outcome complications in 262 expansions.

Total Complications	73/262 (27.9%)
Solved Complications	43/262 (58.9%)
Not Solved Complications (Influencing the final outcome)	30/262 (41.1%)



Fig. 1a: Young patient with severe burns of the face and neck.



Fig. 1b: During skin expansion.



Fig. 1c: Post-operative view.



Fig. 1d: During re-expansion.



Fig. 1e: Final result one year after surgery.



Fig. 2a: Burn sequelae on the chest, involving the mammary area.



Fig. 2b: Planned skin expansion.



Fig. 2c: The patient before the removal of skin expanders.



Fig. 2d



Figs. 2d, e: The final outcome 2 months later.

The higher incidence of complication was noted in the neck and in the lower limb. In the neck anatomy may represent the main limit to skin expansion; so the complication in this area are always to be feared (25, 31, 32). Furthermore the expanded skin is often insufficient, and re-expansion is frequently required (5, 7, 13, 14). Moreover, in this area scars are often wide and hypertrophic: this is due to the capsule contraction (for this reason some surgeons point out that capsule removal is mandatory) (5, 6), and to the difficulty to anchor the expanded flaps on the underlying structures (14).

Tissue expansion in the trunk works well when utilized with careful planning and patience; the same for the extremities. In the thigh and buttocks regions it was more successful than when performed below knee or in the upper limb (3, 6, 20, 28).

Our results were generally satisfactory (Figs. 1 and 2), with an improvement of scars and minimal donor site morbidity. With an appropriate and careful patients selection, complications can be kept minimal, and successful results achieved (7, 8, 13, 16).

In some cases, however, the new scar may present wide, red and hypertrophic: in fact stretchback effect sometimes occurred to some degree, so that later scar revision should be considered (11, 17). For these reasons wrapping the expanded flaps with elastic pressure dressing for some months after surgery may aid on a cosmetic point of view and in refining contour.

CONCLUSIONS

Skin expansion has greatly facilitated reconstruction in burn scar areas, especially in head and neck. In addition, pain and scarring of graft and flaps donor sites are avoided (6), but patient selection is of primary importance in considering this type of reconstruction.

Despite the high total rate of complications did not compromise the final results, and expansion showed several advantages over the traditional and old techniques (Fig. 3).



3a)



Figs. 3a, b: Burn sequelae in the neck: pre-operative view. 3b)



Fig. 3c: Infection with extrusion of the implant close to the end of the inflation time.



Fig. 3d: Good, even if partial result.

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SOUHRNÝ ČLÁNKŮ

Faktory ovlivňující přežití a kvalitu dalšího života u popáleninového úrazu

R. Konigová

Důležitým faktorem majícím vliv na vyšší procento přežívajících pacientů je organizace péče o popálené. Těžce postižení patří do specializovaných center. Tato centra určují směrnice pro neodkladnou péči, třídění, transport a zajišťují multidisciplinární léčbu s použitím nejmodernějšího technického vybavení. Jakýkoli neodborný či nevhodný zásah v průběhu resuscitace (ventilace, cirkulace) nebo intenzivní péče (chirurgické výkony, výživa, infekce) mohou zhoršit krátkodobě výsledky.

Význam „doprovodu“ pro přežití popáleného byl prokázán jak v akutním období, tak v období rehabilitace a rekonstrukce, kdy tvoření a zranění jizev je rozhodující pro kvalitu jeho života. Tvorba a zranění jizev jsou ovlivněny individuálními a rasovými rozdíly a psychickým stavem pacienta.

Je třeba zvážit i celkový fyziologický stav každého jednotlivého nemocného. Mezi faktory, které ovlivňují dlouhodobé výsledky a kvalitu života, patří věk, průvodní onemocnění, rodina a sociálně-kulturní zázemí. Pacienti se lépe přizpůsobují zhoršené zdravotní situaci, pokud si zachovávají určité uspokojení či smysl života. Ti, kteří přestáli kritický úraz mohou nalézt dokonce větší životní satisfakci, i když kvalita jejich života se může zdát snižená.

Vliv pokroku v léčbě závažných popálenin na kvalitu života

S. Teich Alasia, C. Castagnoli, M. Calcagni, M. Stella

Problémy týkající se léčby popálenin mohou být zařazeny mezi nejstarší a nejvíce zkoušené v historii medicíny. Od počátku 40. let nastal pozoruhodný pokrok ve výzkumu patofyziologie popáleninového úrazu. Rychlý vývoj resuscitační techniky podnítil pozoruhodné snížení mortality v první fázi. Infekční komplikace byly významně redukovány jak novými lokálními a celkovými prostředky v antibakteriální léčbě, tak novou koncepcí jednotek intenzivní péče pro popálené. Pacienti jsou zde izolováni a je jim zaručena vysoká úroveň kontroly prostředí.

V chirurgické léčbě včasná tangenciální excise a kultivace epidermálních štěpů mohou být považovány za pokrok v popáleninové terapii. Kvalita života popálených pacientů je významně zlepšena těmito technickými pokroky. Následky

popálenin však zůstávají středem zájmu u přežívajících pacientů pro rozmanité názory na patofyziologii a léčbu jizev.

Celý svůj profesionální život jsem věnoval této oblasti výzkumu. Chci popsat výsledky všech zajímavých klinických a experimentálních studií vytvořených v posledních 30 letech naší skupinou spolupracující se základním výzkumem. Všechny práce v této oblasti zvyšují naši naději, že dobré výsledky mohou skutečně zlepšit kvalitu života popálených. Toto je cílem těch, kteří věnovali celý život zmenšení utrpení těchto těžce poraněných pacientů.

Faktory ovlivňující časnou prognózu u popálenin

T. Raff, G. Germann, U. Barthold

Cíl: 1. Přezkoušet prognostický význam jednotlivých faktorů, které jsou užívány v příjmových skóre u popálených pacientů (věk, rozsah TBSAB, hloubka, inhalační trauma IHT, pohlaví). 2. Zhodnotit, zda rizikové faktory (alkohol, nikotin) nebo předchozí choroby, ovlivňují významně prognózu.

Program: Retrospektivní studie s prospektivně sebranými daty.

Pacienti: V období pěti let bylo přijato na jednotku intenzivní péče 498 nemocných s průměrným rozsahem postižení 29 % a průměrného věku 38 let. 42 % pacientů utrpělo popáleniny větší než 30 % a výskyt inhalačního traumatu dosáhl 43 %.

Metody: Ke stanovení nezávislosti vztahu faktorů určujících úmrtnost byla použita jednosměrná analýza. Doplnující analýza podskupin užila tzv. CART (classification and regression trees).

Výsledky: Jednosměrná analýza určila znaky mající významný vliv na úmrtnost: věk, rozsah, hloubka, inhalační trauma, pohlaví, alkoholová závislost (AA), nikotinová závislost (NA), kombinace AA + NA, předchozí neurologické choroby a kardiovaskulární onemocnění. Postupná (step-wise) logistická regresní analýza určila jako nejdůležitější faktory věk a rozsah. Menší závažnost přisoudila IHT, a pak teprve následovala hloubka a pohlaví. Přitom IHT ovlivňovalo úmrtnost 1,7 krát více než hloubka a pohlaví, a to u všech pacientů, zvláště pak u postižených s rizikem mortality mezi 20-40 %. V této skupině se mortalita výrazně zvyšovala vlivem AA a NA.

U skupin pacientů s vyšší nebo nižší pravděpodobností úmrtí neměly AA a NA na výsledek vliv. CART analýza určila jako nejvýznamnější faktor TBSAB, pak následoval věk.

U skupiny do 20 % TBSAB měl věk zásadní vliv na prognózu. U skupiny mezi 20 a 60 % TBSAB byly významnými faktory věk, pohlaví a AA. U pacientů do 72 let věku se středním rizikem mortality (20 - 70 %) byl výsledek významně ovlivněn IHT, AA, NA, pohlavím, předchozími chorobami neurologickými a kardiovaskulárními. U starších jedinců bylo IHT jediným důležitým faktorem.

Závěr: Studie ukázala, že kromě klasických faktorů určujících závažnost popáleninového úrazu, jimiž jsou věk, TBSAB, IHT, jsou významnými i pohlaví, AA, NA a předchozí choroby, a to zvláště u skupiny pacientů se středním rizikem mortality.

Vývoj a využití psychometrické stupnice pro měření kvality života popálených pacientů od roku 1976 do roku 1996

A. M. Munster, J. A. Fauerbach, J. Lawrence

Specifická zdravotní stupnice pro popáleninové trauma byla původně vyvinuta v r. 1978. Vychází z četných již existujících zdravotních stupnic, včetně impaktu nemocnosti, stupnice deprese a denních aktivit, přičemž široký počet specifických prvků z popáleninové problematiky byl odvozen z návrhů personálu a pacientů. Posléze byla vyvinuta stupnice, obsahující 80 položek. Tato stupnice byla rozdělena do čtyř oblastí, z nichž každá obsahovala 20 položek stejné závažnosti. Stupnice byla ověřena následovně systémem intrarater, interrater a souhrnným ověřovacím systémem a byla dodatečně porovnána s určitým počtem dalších zdravotních a mentálních stupnic, kdy se velmi dobře osvědčila.

Nyní máme longitudinální data, která srovnávají systém měření kvality života s úrovní vzdělání před poraněním, se stavem po poranění, se stresovými poruchami a pravděpodobností návratu do zaměstnání. Výsledky ukazují, že celkový rozsah popálení neovlivňuje kvalitu života po uzdravení, ale že větší roli hrají další faktory, jež jsou prezentovány.

Náhrada tekutin u popálených pacientů

A. Bortolani, M. Governa, D. Barisoni

Popáleninové trauma je spojeno se značnou ztrátou vody, elektrolytů a proteinů. K ovlivnění

rozvoje šoku je nezbytný velký přívod tekutin v prvních hodinách po úrazu. V minulých letech byly navrženy mnohé resuscitační formule rozličného složení: fyziologický roztok, koloidy, plazma. Autoři studovali 40 popálených pacientů přijatých do Veronského popáleninového centra v průběhu prvních čtyř hodin po popálení s postižením přesahujícím 30 % povrchu těla. 20 z nich bylo léčeno Baxterovou resuscitační formulí (Ringer - laktát, RLS) a ostatní pomocí formule Monafo (hypertonický roztok s laktátem, HLS) modifikované Milánským centrem popálenin. Byly vytvořeny a porovnány dva náhodné soubory. U RLS skupiny bylo celkové množství tekutin vyšší, zatímco potřeba sodíku byla nižší než u HLS pacientů (se statisticky významnou diferencí $p < 0,01$). A naopak u skupiny HLS bylo podáno 2x více draslíku ve srovnání s druhou skupinou. Hematokrit, výdej moči, osmolarita moči byly v obou skupinách odpovídající a nevykazovaly statistický rozdíl. Koncentrace sérových proteinů byla nízká u všech pacientů, zatímco u osmolarity moči byl pozorován signifikantní rozdíl ($p < 0,01$). Metabolická alkalóza byla přítomná u HLS pacientů, zatímco sérový dusík byl signifikantně vyšší ($p < 0,05$) v prvních 48 hodinách po popálení u RLS skupiny. Pacienti byly rozděleni i z hlediska předcházejících onemocnění a získaná data prokázala nižší výskyt komplikací u HLS skupiny než u skupiny RLS.

HLS resuscitační formule zaručuje dobrou elektrolytovou rovnováhu, nízkou tekutinovou nálož, čímž je snížena edém tkání a nižší výskyt komplikací. Úmrtnost byla vyšší u HLS skupiny, což mohlo být způsobeno vyšším Royovým indexem v této skupině.

Neodkladná léčba a včasná tekutinová resuscitace u úrazů elektrickým proudem

M. Colic, L. Ristic, M. Jovanovic

Poranění způsobená vysokým napětím elektrického proudu jsou vzácná, ale patofyziologicky významná svými destruktivními účinky. Jako forma termického traumatu reprezentuje elektrické poranění spojení popálené kůže a destrukci hlubokých tkání, jejíž hloubku nelze předpovědět. Poranění většinou připomíná rozdrcenou tkáň.

Neodkladná léčba začíná oddělením popáleného od elektrického proudu (zrušení kontaktu) a zajištěním rychlého transportu do nejbližšího zdravotnického zařízení vybaveného k provádění kardiopulmonální resuscitace a k poskytování komplexní péče. Resuscitace pacienta po elektrickém šoku pokračuje náhradou tekutin použitím speciální formule modifikované pro tyto případy, korekcí acidózy a myoglobinurie. Escharotomie a fasciotomie jsou nezbytné.

Zkušenosti s modifikovanou MEEK technikou

T. Raff, B. Hartmann, H. Wagner, G. Germann

V roce 1958 popsal Meek tzv. Meek-Wallův dermatom na získávání kožních štěpů velikosti poštovní známky. Tato metoda byla spojena se zavedením meshovaných kožních štěpů. V roce 1993 Kreis a jeho spolupracovníci vytvořili modifikovanou Meek techniku za použití dermatomu poháněného stlačeným vzduchem. Tato technika se v našem popáleninovém centru používá od roku 1994. Zde bychom chtěli srovnat modifikovanou Meek techniku s technikou meshovaných štěpů.

V průběhu 20 měsíců byla tato metodika použita při léčbě (krytí) 41 pacientů. Průměrný rozsah postižení byl 54,4 % povrchu těla s 50,0 % popálení III. stupně (v plné tloušťce). U všech pacientů byla provedena časná excise. Expanzní poměr byl 1:4 a 1:6. U 20 pacientů byla Meek technika užita výhradně pro krytí trupu a končetin a nikoliv pro obličej, krk a ruce. U tří pacientů s průměrným postižením na 68,3 % povrchu těla byla použita kombinace známkových dermoepidermálních autotransplantátů a kultivovaných epiteliálních autologních štěpů.

Ve srovnání s technikou meshovaných štěpů vykazuje Meek technika následující výhody: 1. Meek technika umožňuje přesný expanzní poměr. 2. Mohou být využity malé zbytky kůže. 3. Krytí popálenin III. stupně až do rozsahu 70 až 75 % povrchu těla je možné při jediném odběru. 4. Spolehlivost přihojení štěpu je stejná nebo lepší. 5. Kryté plochy epitelizují v průběhu 3 až 4 týdnů podle expanzního poměru. 6. Kombinace široce expandovaných známkových štěpů s kultivovanými epiteliálními autologními štěpy umožňuje vynikající rychlost přihojení a trvalý kožní kryt v krátkém čase a řeší problém přihojení kultivovaných štěpů na fascii. Tato metoda je jednoduchá, ale náročnější než meshovací technika. Ve srovnání s technikou meshovacích štěpů je příprava Meekových štěpů časově náročnější a vyžaduje více personálu. Cena materiálu je vyšší. Podle našich zkušeností úplné krytí Meekových štěpů meshovanými alotransplantáty po odstranění tylu, jak doporučuje Kreis, není při expanzním poměru 1:4 potřebné. Při větších expanzních poměrech je překrytí meshovanými alotransplantáty nezbytné. Ve srovnání s technikou meshovaných štěpů nebyly pozorovány signifikantní rozdíly ve tvorbě jizev. Závěrem lze říci, že

modifikovaná Meek technika je spolehlivá a jednoduchá. Tato technika nám poskytuje dostatečný expanzní poměr umožňující transplantovat pacienty s rozsahem popálenin do 75 % tělesného povrchu z jediného odběru bez použití kultivovaných štěpů. Podle našich zkušeností je Meek technika výhodná u pacientů popálených na více než 45 % tělesného povrchu. U menších popálenin jsou výhodnější meshované štěpy vzhledem k nižším materiálovým nákladům a nárokům na personál. Především u rozsáhle popálených pacientů může být Meek technika cenově výhodná, neboť nahrazuje kultivované epiteliální štěpy.

Kožní expanze u následků popálenin. Výsledky a komplikace

M. Governa, A. Bortolani, D. Beghini, D. Barisoni

Dříve než Radovan zavedl kožní expanze, byly popáleninové defekty léčeny kožními štěpy, místními nebo vzdálenými laloky s vysokým procentem komplikací v místě odběru. V současné době se stala tato technika standardním výkonem, který umožňuje získat místní laloky stejné charakteristiky v barvě, složení, citlivosti a ochlupení, jako normální kůže.

Autoři analyzují své zkušenosti v léčení popáleninových následků od r. 1985 do r. 1995. V průběhu tohoto období podstoupilo 157 pacientů chirurgický zákrok korigující popáleninové jizvy a kontraktury. Při těchto výkonech bylo použito 262 kožních expandérů. Inplantáty byly umístěny na fascii; běžně byla použita antibiotika a drenáž. Plnění expandéru bylo zahájeno 2 týdny po chirurgickém výkonu, a pokud to bylo možné, byl hyperexpandován pravidelně. Pouze u 6,4 % (10 pacientů) expanze selhala, zatímco u ostatních případů bylo docíleno dobrých částečných (u pacientů s příliš rozsáhlými jizvami) nebo úplných výsledků. Výskyt komplikací je u kožní expanze vysoký, u 262 expanzí se vyskytly 73krát. U 43 případů byly snadno řešitelné, takže pouze u 30 případů byl konečný výsledek ovlivněn komplikací, hlavně v oblasti krku a dolních končetin. U vhodných pacientů poskytuje kožní expanze uspokojivé řešení s omezením komplikací a docílením dobrých výsledků.

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CONTENTS Vol. 38, 1996

- Bhathena, H. M., Savant, D. N., Kavarana, N. M., Parikh, D. M., Sanghvi, V. D.: Reconstruction with Different Free Flaps in Oro-facial Cancer Patients*43
- Bhathena, H. M.: Caudal Trapezius Composite Island Flap for Extensive Shoulder Defects*90
- Bortolani, A., Governa, M., Barisoni, D.: Fluid Replacement in Burned Patients*132
- Bursa, V., Pizinger, K., Šolc, J., Stuchlová, A., Šormová, K.: Our Experience with Operative Treatment of Malignant Melanoma*21
- Campiglio, G. L., Candiani, P.: Surgical Anatomy in Endoscopic Facial Rejuvenation*3
- Colić, M., Ristić, L., Jovanović, M.: Emergency Treatment and Early Fluid Resuscitation Following Electrical Injuries*137
- d'Arcangelo, M., Mafulli, N.: Tissue Expanders in Syndactyly: A Brief Review*11
- Governa, M., Bortolani, A., Beghini, D., Barisoni, D.: Skin Expansion in Burn Sequelae: Results and Complications*X
- Kletenský, J., Tvrdek, M., Pros, Z., Nejedlý, A., Svoboda, S.: Treatment of Defects and Instable Skin Scars on Heavily Exposed Parts of the Leg*87
- Konigová, R., Tvrdek, M.: Consideration on Classic Methods and Free Flaps in Face and Neck Reconstruction*14
- Konigová, R.: Do-not Resuscitate Orders and Withheld or Withdrawn Treatment*73
- Konigová, R.: Factors Influencing Survival and Quality of Life in Burns*116
- Krásničanová, H., Zemková, D., Škodová, I.: Longitudinal Follow-up of Children after Surgical Treatment of Scaphocephaly*50
- Kruk-Jeromin, J.: Construction of Neophallus in Male Pseudohermaphroditism*104
- Kudrová, J., Borský, J., Černý, M., Müllerová, Ž., Vohradník, M., Hrivnáková, J.: Care of Patients with Facial Clefts at the Department of Plastic Surgery in Prague*99
- Müllerová, Ž., Brousilová, M., Jiroutová, O., Somrová, S.: Dental Care in Patients with Facial Clefts*37
- Munster, A. M., Fauerbach, J. A., Lawrence, J.: Development and Utilization of a Psychometric Instrument for Measuring Quality of Life in Burn Patients, 1976 to 1996*128
- Peterka, M., Peterková, R., Halašková, M., Tvrdek, M., Fára, M., Likovský, Z.: Sex Differences in the Incidence of Orofacial Clefts and the Question of Primary Prevention in Families with Genetic Risk*57
- Pros, Z., Tvrdek, M., Kletenský, J., Nejedlý, A., Svoboda, S.: Chronic Traumatic Wounds of the Leg*83
- Ramba, J.: Fixation of the Tongue below Mandible in Pierre Robin Syndrome*54
- Ramba, J., Doskočil, M.: Caput Mandibulae Accessorium*94
- Raff, T., Germann, G., Barthold, U.: Factors Influencing the Early Prediction of Outcome from Burns*122
- Raff, T., Hartmann, B., Wagner, H., Germann, G.: Experience with the Modified Meek Technique*142
- Smrčka, V., Hrbatý, J., Holuša, P.: Microsurgical Reconstruction of a Stiff Jointless Thumb after an Avulsion Injury*24
- Smrčka, V., Samohýl, J., Holuša, P.: Long Time Follow-up of Flexor Tendons of the Hand after Reconstructive Operations (Part 1: Monitoring Method)*61
- Škvařilová, B., Plevková, A.: Ranges of Joint Motion of the Adult Hand*67
- Šmahel, Z., Müllerová, Ž., Horák, I.: Facial Development in Unilateral Cleft Lip and Palate Prior to the Eruption of Permanent Incisors after Primary Bone Grafting and Periosteal Flap Surgery*30
- Teich - Alasia, S., Castagnoli, C., Calcagni, M., Stella, M.: The Influence of Progress in the Treatment of Severe Burns on the Quality of Life*119
- Instructions to Authors*40, 72, 111
- Sumaries in Czech*78, 110, 157

INDEX

Acta Chirurgiae Plasticae 38, 1996

A

accessory head*94
ankyloglossis*54

B

bone graft*30
burn injury*14, 116, 119, 122, 128, 132, 137, 142, 147

C

cleft lip*57, 99
cleft lip and palate*37
cleft palate*57, 99
compound shoulder defects*90
computer monitoring*61
condylus bifidus*94
congenital hand deformities*11
construction of neophallus*104

D

dental care*37
direct cephalometry*50
dysmorphobia*116

E

early childhood*30, 37
electrical injuries*137
endoscopy*3
eubiosia*116
ethical principles*73

F

face*3, 14, 30
facial development*30
fasciotomy*137
flexor tendons*61
fluid replacement*132, 137
free bone flaps*50
free flap reconstruction*43
free muscle flap*83
free tissue transfer*24
futile treatment*73

G

genetic risk*57

H

hand*24, 61, 67
head and neck cancer*43
hypertrophic scars*119

CH

chronic defect*83, 87

J

joint motion*24, 67

M

male pseudohermaphroditism*104
malignant melanoma*21
mandible anomaly*94
measuring quality of life*128
medical ethics*73
microsurgery*24, 83, 87
mortality*122

N

norms*67

O

orthodontic therapy*37

P

periosteal flap*30
progress in burn care*119

Q

quality of life*116, 119, 128

R

reconstruction of jointless thumb*24
reconstruction of face and neck*14
resuscitation*137
rhitidectomy*3
risk factors*122
Robin syndrom*54

S

scaphocephaly*50
scar formation*116
scoring methods*122
secondary cartilage*94
sex choice*57
skin expansion in burns*147
skin scars of the leg*87
skin transplantation*142
sensitive flap*87
stress*116
surgery*142

T

tissue fixation*54
trapezius composite flap*90

U

unilateral cleft lip and palate*30

ANNOUNCEMENT

European Burns Association

7th International Congress Leuven

Belgium, September 18-20, 1997

The Seventh International Congress of the European Burns Association will be organised in collaboration with the „Belgian Association for Burn Injuries“ in Leuven, Belgium from September 18-20, 1997.

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