PRELIMINARY ESTIMATION OF THE PROGNOSTIC VALUE OF THE HAEMODYNAMIC RESULTS OF DOPPLER EXAMINATION IN SEVERELY BURNED PATIENTS

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SUMMARY. It is difficult to define all cardiac risk factors in the course of burn treatment. The adequate function of the circulatory system is the main factor in successful therapy. The aim of this study was to define, using a transoesophageal Doppler system, the cardiac circulatory risk factors of death in burn patients. One hundred and forty-seven burn patients were divided into two groups defined as survivors and non-survivors. In both groups the following haemodynamic parameters were analysed: 1. cardiac output; 2. stroke volume (SV); 3. heart rate (HR); 4. flow time (FT); 5. peak velocity; 6. average acceleration. The differential statistical significance was evidenced by analysis of SV, FT, and HR, using the ANOVA test. All the results showed that the best predictor factors for survival were SV and HR.

Introduction

The estimation of prognostic factors in burns has long been a significant problem. The basis of prognosis has been the clinical evaluation of the burn wound, including burn surface area and depth, coexisting airway injuries, age, and the intensification of septic processes.[1]

In the course of burn pathophysiology studies, many phenomena have been discovered that have permitted the clinical evaluation of the significance of multi-organ failure, as also of its respective constituents, including circulatory system disorders.

Circulation homeostasis constitutes the basic condition for successful treatment of all medical conditions, and of traumas in particular.

This paper compares the statistical significance of the particular haemodynamic parameters examined using non-invasive methods, in the group of patients who died as a result of their burns, with the values found in the group of patients who survived.

Materials

The group of patients analysed comprised 145 patients hospitalized in the Siemianowice Burns Centre, Silesia, in 1998-1999 with a diagnosis of burns in 30-70% total body surface area and of depth estimated on admittance to be of second, second/third, third, and third/fourth degree. After overcoming the shock period, the patients were sent on for surgical treatment and general anaesthesia. In view of the absence of operational risk specific to burns, the patients were evaluated on the ASA scale.

The characteristic features of the deceased patients were as follows: number = 33, average body mass = 74.13 kg, average height = 172.85 cm, average age = 36.69 years (*Table I*). The group of survivors who overcame the complications of the burn disease presented the following characteristics: number = 102, average body mass = 70.59 kg, average height = 171.96 cm, average age = 45.67 years (*Table I*). There were 16 women and 129 men.

Table I - Demographic characteristic of survivor and non-survivor groups of burn patients

	Survivors	Non-survivors
Average body mass (kg)	70.5	74.1
Average age (yr)	45.6	36.7
Average height (cm)	172.0	173.0

Surgical procedures such as deep and tangential necrosis excision and skin transplantation were performed from 3 to 7 days after occurrence of the trauma.

Anaesthesia was conducted as follows: 1. with TIVA modification estimated as TCI using a Graseby 3000 Diprifusor pump; 2. with complex anaesthesia (Thiopental Spofa, Czech Republic; Fentanyl Polfa, Poland; Atracurium Glaxo Wellcome, Great Britain) and O_2/N_2O mixed in variable proportions. In these subgroups, identical haemodynamic parameters were evaluated.

Methods

Haemodynamic examination was conducted with ODM II (Abbot Laboratories) and with ultrasound trans-

oesophageal probe of continuous signal emission. The measurement was performed at the descending aorta at 10-min time intervals in general anaesthesia, with the first measurement being made after intubation of the patient. The methods of anaesthesia were as described above. The following parameters were assessed:

- minute cardiac output (CO) (l/min)
- stroke volume (SV) (ml)
- heart rate (HR) (number/min)
- average flow time (FT) (sec)
- peak velocity (PV) (ml/sec)
- mean acceleration of stream (MA) (ml/sec^2)

Statistical analysis

The numerical data obtained were subjected to statistical analysis with the Statistica 5.0 program, applying the ANOVA test of variant analysis by Kruskall-Wallis, as also the Newman-Keuls test.

Results

The numerical data of each haemodynamic parameter in the groups compared are given in *Table II*.

Table II - Descriptive statistics of haemodynamic parameters in survivors and non-survivors

	Survivors	Non-survivors
CO (l/min)	4.38	3.94
SV (ml)	44.52	34.22
HR (number/min)	102.53	116.61
PV (ml/sec)	63.11	60.92
FT (sec)	0.27	0.24
MA ml/sec^2	6.84	7.0

In the non-survivor group, significant statistical analysis values were found in relation to the following parameters: SV (average) = 34.227, p = 0.00; HR (av.) = 116.609, p = 0.00; FT (av.) = 0.236, p = 0.00; age (av.) = 36.697, p = 0.0018; CO (av.) = 3.943, p = 0.00186 (*Table III*).

Table III - Comparison of statistical significance of haemodynamic parameters analysed in survivors and non-survivors

	Survivors	Non-survivors	*p*
CO	4.38	3.9	0.03
SV	44.52	34.22	0.00
HR	102.54	116.61	0.00
PV	63.11	60.90	0.09
FT	0.27	0.24	0.00
MA	6.85	7.0	0.34

In the survivor group, the relative values were as follows: SV (av.) = 44.522, p = 0.00; HR (av.) = 102.535, p = 0.00; FT (av.) = 0.267, p = 0.00; age (av. = 45.673, p = 0.0018; CO (av.) = 4.378, p = 0.00186 (*Table III*).

In this material, what strikes the attention is the significant value differentiating both groups of such parameters as stroke volume, heart rate, and flow time. Age appears to be less significant, as also cardiac output, which seems rather surprising. Regarding the other parameters specified, no statistically significant results were found.

Discussion

The prognosis of survival in burn patients is difficult, and existing scales on post-traumatic conditions in general are not precise enough for them to be related to burns. Classic trauma severity scores such as ISS (injury severity score), as also pathophysiological scores such as subsequent versions of APACHE, possess few elements that are specific for burn trauma, as pointed out by Vassar and Hollcroft.[2]

Burn disease is systemic in character, and existing changes directly or indirectly involve the myocardium. The clinical manifestation and intensification of pathology seem to depend on initial burn depth, the stage of disease development when measurements were taken, and the invasiveness of any surgical treatment performed.

The efficiency of the circulatory system is one of the basic conditions of successful treatment in all traumas, while cardiac output is a sensitive standard of muscle efficiency as a pump.

In view of the general aim of this paper, the respective depths of burn wounds were not distinguished as separate groups and it was thus possible to obtain general data which are capable of providing visualization of the patient's haemodynamic profile and which also make it possible to draw prognostic conclusions.

The significantly lower SV values in the deceased group of patients may suggest decreased diastolic susceptibility in the left ventricle, which is also supported by the shortening of FT in this group. Hungarian doctors accept this parameter as the initial load standard and, partly, as the exponent of the left chamber with respect to its stroke period.[3] The significance of FT was similarly evaluated by Badaoui and Galan, who analysed the haemodynamics of patients during laparoscopic procedures.[4] Chamber susceptibility decrease may result from relative hypervolaemia or from oedema accompanying the burn disease.

A similar haemodynamic picture was found by Adams, Baxter, and Parker in 1982. Their studies confirmed an increase in the left chamber filling pressure procedure, without however any increase in the total content of tissue water, and a statistically significant increase in initial load value.[5]

Suzuki et al. examined preload value decrease and minute output in burned sheep. In their view, the haemodynamic parameters were dependent on the manner of management of fluid resuscitation. A similar opinion was pronounced by Miller et al., who indicated fluid resuscitation that was inadequate for needs as the basic factor in circulation inefficiency in the early stages of burn.[6]

As said, the relatively low statistical significance of minute output is a subject of deliberation. It may however be due to error in the method, as also suggested by the comparative studies of Velmahos et al.,[7] who evaluated the usefulness of other methods of non-invasive haemodynamic monitoring in post-traumatic stages when projection values remained decreased only in the early stages of treatment. At the same time, the fact that output values are made up for by tachycardia is highly probable. Although the mechanisms of this phenomenon are not clear from the reports of Spis et al.[8] related to prognosis in the course of septicaemia and indicating the prognostic significance of ST-T distance examination, as also from research by Gueugniaud et al.[9] relative to prognosis in burns to interleukin-6 concentration, one may presume the significance of septic factors in the development of the haemodynamic changes observed by these authors.

Heart rate is subject to the influence of many intracardiac and humoral factors that are not always distinguishable. The analysis of such aspects considerably exceeds the scope of this report, and in the context of burns does not make it possible to draw conclusions, also due to lack of data in the literature.

To sum up, our individual research and the absence of data in the literature do not enable us to draw reliable prognostic conclusions based on the haemodynamic examination of burned patients using the method adopted. The evaluation of prognosis in the burn disease should be multifactorial in character, and this requires further clinical and biochemical studies, plus the constant improvement of monitoring methods.

Conclusions

1. The basic parameters that distinguish between the groups analysed are stroke value, flow time, and heart rate.
2. The results obtained from statistical analysis may indicate the haemodynamic features of heart failure, mainly within the diastole range. However, this requires confirmation by other methods.

RÉSUMÉ. Il est difficile de définir tous les facteurs de risque cardiaque au cours du traitement des brûlures. Le fonctionnement suffisant du système circulatoire constitue le facteur principal du succès de la thérapie. L'Auteur de cette étude a voulu définir, avec l'emploi d'un système Doppler transoesophagien, les facteurs de risque cardiaque circulatoire de mort dans les patients brûlés. Cent quarante-sept patients brûlés ont été divisés en deux groupes définis comme survivants et non-survivants. Les paramètres hémodynamiques suivants ont été analysés dans les deux groupes: 1. débit cardiaque; 2. volume de course (VC); 3. fréquence des pulsations cardiaques (FPC); 4. temps d'écoulement (TE); 5. vitesse maximale; 6. accélération moyenne. La signification statistique différentielle a été documentée par l'analyse du VC, du TE et de la FPC, en utilisant le test ANOVA. Tous les résultats ont démontré que les meilleurs facteurs pour la prédiction de la survie sont le VC et la FPC.

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