ed in the near future. This is very difficult despite increased energy potential, fermentative activity of muscular tissue, increased cardio-respiratory capacity etc.

Against the background of failing restoration, the strong, and even middle in strength stresses have the same effect as excessive stress ih terms of changes in the homeostasis. Because of the weaker intensity of proprioceptive nerve impulses the exposure to stress can continue for several_fold layer periods of time. As a result essential changes can be observed in the organism. After a series of such loadings, the restoration is completed at the end of the microcycle with a very well expressed phase of overrestoration. The action of middle and strong stimuli as superstrong under conditions of incomplete restoration offers great possibilities for further perfection and rationalisation of the training process.

The principally new structure of hard training stresses and its physiological and biochemical implication pose some important problems to sports medicine, such as:

1. Training stress assessment could not be exact if based on absolute measurements of work load (strength, range, intensity), changes in vegetative indices during the loading etc. Physiological and biochemical methods which give a notion (if possible a quantitative one) about the specific result of loading are essential for the efficiency of training. For instance determining the indices of acid-base balance, the lactates content, the degree of consumption of some energy substances etc.

2. The above scheme of training loadings pose the question of a new approach to the problem of restoration. It would be hardly expedient to apply active restoration means after each single workout. On the contrary, as soon as the microcycle is over, it

is necessary to resort to complex recovery procedures with a view to the complete restoration and overrestoration of the organism. The basic task is by no means to accelerate restoration. It is more important to secure conditions for a complex recovery of the organism.

3. Especially important is the role of alimentary and overall biological restoration of the organism. According to the desired trend of biochemical overrestoration, the food, drinks and the salts administered should contain enough of these substances or their ingredients. Their increased contents in the organism determines the high capacity for exertion in the respective sport.

Regardless of the fact that biochemistry has given us a rather detailed characteristics of metabolism in the basic types of physical effort, sports medicine has not solved sufficiently well the practical problems concerning feeding and biological stimulation. Further studies in this line should be directed towards controlling the regulation of restoration processes in the desired trend.

4. It is necessary to revise the concepts concerning the optimal pulse rate during workouts in order to increase the aerobic capacity of outstanding athletes. The 140 - 150 pulse rate range recommended by most authors, is hardly the optimal one. At the latter pulse rate the aerobic capacity is barely about 50% of the maximum. It is only at pulse rate 180-190 that the oxygen consumption reaches values approaching the maximum aerobic capacity (80 - 90 % of the maximum). Such is (around 90 % of the maximum also the usual intensity of the training stress in top level athletes. Some rational suggestions deserve attention and further elaboration. For instance, workouts may take place in unusual atmospheric and

temperature conditions. Hypoxic training is especially perspective. In condition of decreased partial oxygen pressure in the inspired air, the normal discrepancy between oxygen supply and the requirements of energy metabolism is increased. The percentage of the anaerobic supply of muscular activity considerably increases. From the point of view of biochemistry this implies an increase of the creatine phosphate and glycolytic mechanism of the anaerobic ATP resynthesis which is related to an enhanced activity of cell ferments. In hypoxic conditions the excretion of lactic and pyruvic acids, and creatine phosphate is increased.

In relation to the problem under consideration noteworthy data were reported by Yakovlev. The eminent Soviet biochemist found out that adaptation changes taking place in the organism of athletes during workouts become a factor interfering with the further efficiency of training stresses. At a higher conditioning level, the further increase of training loads may result in insignificant disturbances in homeostasis, and in the balance of ATP. In the opinion of Yakovlev, a physiological-chemical total affect takes place which makes it possible to carry on the work without appreciably upsetting the homeostasis. The conditioning level, at a given stage of its development, becomes a hindrance for the further perfection of physiological and biochemical processes within the organism.

According to Yakovlev a rational path towards a further increase of the adaptation of the organism is to include additional factors disturbing the homeostasis. Reference is made, first and foremost to hypoxic training.

Another additional factor which causes a perceptible disturbance of homeostasis, and stimulates the adaptation and regulation mechanisms is the temperature. Workouts in changed temperature conditions, as proved by a number of biochemical investigations, might cause a stronger disturbance of homeostasis and more significant adaptation changes.

Electrocardiographic investigations abroad and in our country (Georgiev, Bitchev) also show a severalfold increase in the variations from the normal ECG. Most authors explain this finding by the high stresses "damage" to the organism of athletes whenever an inadequacy is present between the size of loading and the adaptability of the organism. Probably these are the real causes for part of the ECG variations observed. This explanation, however, is unsatisfactory in cases with an obvious discrepancy between "the patological" findings in ECG according to our traditional beliefs, and the high functional possibilities of the organism, including the heart, which have been found in complex functional studies of athletes.

A more serious re-assessment of the existing concepts concerning the adaptation of organism to high training loads, and the borderline between norm and patology is imperative.

INFLUENCE OF SOME METABOLITES ON ELECTROLITE METABOLISM AND ACID-BASE BALANCE CHANGES IN THE ORGANISM DURING PHISICAL STRESS AND REST

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Recently sports researchers /physicians, biochemists, physiologists, sports pedagogues and psychologists/ are ever more interested in the problems of recovery from athletic exertion of varying intensity and duration. To establish the regularities of the recovery processes, as well as to detect factors which can actively accelerate these processes is a difficult but rewarding activity whose success can help the athlete's organism both to avoid the serious consequences of overfatigue, and to extend its possibilities of enduring greater training loads and achieving higher performances.

The study of recovery processes after athletic efforts shows that biochemical changes in the biological fluids of organism /blood and urine/ point to corresponding changes in the cells of organs and systems, basically engaged in sports. Investigations on some parameters of the biological fluids during recovery after athletic exertion, as well as when applying some metabolites, can be a good appraisal of the rate of the recovery processes and of the expedience from application of various metabolites.

Application of some metabolites is aimed at mitigating these changes in sports efforts, and by accelerating the recovery processes-to improve indirectly the capacity of work

In our investigation we have used the preparation Kasevit produced by us, with the following composition: casein hydrolysate, creatine, succinate, fumarate, glycerophosphate and vitamin C. To establish the separate effect of each ingredient on the parameters investigated, we have carried out several experiments with tablets Casein hydrolysate - Creatine; Casein hydrolysate - vitamin C; Casein hydrolysate - glycerophosphate. In order to avoid the suggestive factor, the examined persons were also given placebo.

EXPERIMENTAL CONDITIONS - 12 individuals-men at the age of 22-28 years, and mean body weight 66 kg were examined. The experimental conditions were described in detail in our previous communications /Ya. Afar et al., Problems of the phys.culture, No 12, p.669,1973, and No 1, p.16, 1974, Sofia/.

The examined persons received 15 tablets of Casevit or placebo each 30 minutes before physical load. The composition of the biostimulator Casevit used has been already described and studied in detail /Ya. Afar, A.Popov - Problems of the physical culture, No 2, 1972/.

METHODS - Sodium and potassium were determined according to flame photometry method: potassium - complexonomometrically; inorganic phosphorus chlorides according to Lowry Lopez; lactate according to Barker and Summerson; the parameters of the acid-base balance /pH, pCO_2, BB, BE, SB - according to Astrup's method.

RESULTS. The concentration changes of the investigated electrolytes /sodium, potassium, calcium, chlorides and inorganic phosphorus/ can be seen in tables 1 and 2. The levels of the investigated electrolytes in Casevit cases as compared with placebo cases showed insignificant differences both immediately after loading and in the 60 minute recovery period.

When taking Casevit immediately after load, /an increase of lactate level by 183.22% relative to initial levels is observed/ pt = 0.9999/. On the 30-th minute after load, recovery of the initial values occurs. On the 60-th minute of the recovery, the lactate level falls to a mean value of 16,50 mg %/pt = 0,9993/. Such a fall was not recorded on the 60th minute of the recovery when taking placebo. Lactate level in these cases does not show any difference as compared to the 30th minute of the recovery.

The actual blood pH /table 2/ in Casevit cases drops statistically reliably -/pt = 0,999/ immediately after physical load and fails to normalize by the end of the 60 minute recovery period. No statistically reliable differences are observed when comparing the initial levels of the actual blood pH both in Casevit and placebo group. pH in the Casevit group reaches lower values immediately after load /pt = 0,9773/ as compared with placebo cases - 7,31 for placebo against 7,26 for Casevit.

Partial CO_2 /table 1 and 2/ shows a decrease by 11,38% /pt= 0,9993/ immediately after load within normal limits, and unlike the placebo cases, it reaches values above the initial ones / pt-0,9676/ within 30 minutes of recovery.

Standard bicarbonate - SB / table 1 and 2/ when taking Casevit is lower than when taking placebo / pt = 0,9497/. The initial values in both groups are reached on the 30-th minute, and once again a difference, although within normal limits, is observed on the 60-th minute / pt = 0,9954/.

The dynamics of BE is similar /table 1 and 2/, with the decrease when taking Casevit being more pronounced, as compared to placebo / pt = 0,9451/ immediately after load. The same value is reached on the 30-th minute, after which the BE values in Casevit cases are reliably lower / pt = 0,9989/, on the 60-th minute.

The buffer bases - BB both in Casevit and placebo cases, diminish immediately after load statistically reliably below the norm /table 1 and 2/, with the fall in Casevit cases being rather marked /pt = 0,9875/. On the 60-th minute of the recovery period, BB approach their initial norm, showing lower values in Casevit cases / pt = 0,9957/.

Taking into consideration the nature of the veloergometric exercise used, it is evident that all experimental subjects performed the same work in terms of range and intensity till the 15th minute of exertion, the capacity of work being the same when taking Casevit and placebo. But after 15 min. the refusal occured in various moments and the capacity for work in this moment was different. From our investigations it is evident that the capacity for work was greater when taking Casevit /6584 kgm/ than when taking placebo /4620 kgm/. Having in mind the body weight data for both groups, we see that working capacity per kg body weight is higher in Casevit cases - 98,68 kgm/kg body weight against 69,56 kgm/kg body weight in placebo cases.

DISCUSSION

The results obtained support some previous observations made by us /Afar, Ya et al. 1973/ concerning absence of changes in the levels of the investigated blood electrolytes in this model of physical exercise, as well as in Casevit cases and in the various combinations.

The changes in lactate blood content when taking Casevit are similar to those established by us in this type of exercise in earlier studies without taking of the preparation /Afar, Djarova, Codova and Popov/. Yet, it must be noted that lower values for lactate concentration are observed on the 60-th minute of recovery when taking Casevit as compared to placebo.

The lower values in Casevit treatment can suggest activation of the decomposition mechanisms in the cycle of the three carbonate acids, taking into consideration the metabolite supply by the cycle itself.

When applying each of the three combinations, one-type characteristic effect is observed during the second half of the recovery period, where a decrease of the obtained on 3 the 30-th minute initial values of lactate concentration was noted between the 30-th and 60-th minute.

As a complex, the preparation Casevit shows analogical effect which warrants the assumption that each of the invpstigated components takes part in the overall mechanism of accelerated recovery.

The results of the studied parameters of the alkaline-acid balance when taking Casevit show that immediately after exertion a metabolic acidosis occurs /decrease of pH, SB and BE/, SB and BE recovering within normal limits on the 30-th minute of the recovery period, without pH normalization. On the 60-th minute of the recovery, pH is not yet normalized, SB and BE being within normal limits, but showing statistically reliably lower values as compared to placebo cases.

These data could be explained, on the one hand, by introducing a certain amount of organic acids from the preparation and, on the other, by the increased capacity upon Casevit receipt.

A correlation between pH, SB and BE changes and the capacity for work has been sought for. The results show a moderate inversely proportional relation between the capacity of work and pH blood values / v - 0,34/, and a slight inversely proportional relation between the capacity for work and blood SB and BE values.

CONCLUSIONS

1. Casevit exerts no influence on the changes in electrolyte content after application of the chosen model of veloergometric exercise.

2. The preparation Casevit influences favourably the changes in blood lactate concentration during the recovery period, thereby improving indirectly the overall capacity for work.

3. The three investigated components: Casein hydrolysate - vitamin Casein hydrolysate - creatine; Casein hydrolysate - calcium glycerophosphate influence the changes in the lactate profile in a pattern similar to the complex preparation Casevit itself.

4. The preparation Casevit improves the absolute capacity for work in this kind of physical exertion.

CHANGES IN GASEOUS EXCHANGE, LACTATE AND ACID-BASE BALANCE OF BLOOD IN ASCENDING INTERVAL LOADS

D.Stefanova, D.Dobrev, T.Djerova - Bulgaria

Utilization of interval loads, applied in different variants is very important in sports training. Their effect on the mechanisms ensuring O_2 supply to the organism has been studied by many authors, but mainly during interval work using equal working periods in terms of time and intensity /J.Keul a. E.Doll,1973; S.Rasmussen,1972, H. Mellerowicz,1972; F.Ferguson, et al., 1970; H.Reindell et al.,1962, etc./.

It is the purpose of this paper to follow up the changes in gaseous exchange, acid-base balance and lactate parameters during interval load with increasing intensity and decreasing time intervals.

Method. 10 active male athletes were investigated, subjected to lading on a veloergometer. It was started with 5 minute warm up with a power of 2W per kg body weight followed by 3 minutes rest after which interval exercises of 5 working periods were carried out according to the scheme: work for 2 min., at a power of 200 W /1200 kgm/min/ - rest - 1 min, work 1 min. and 30 sec. at 250 W /1500 kgm/min/ - rest 45 sec., work 1 min. at 300 W /1800 kgm/min/ - rest 30 sec., work - 30 sec. at 350 W /2100 kgm/min/ - rest 15 sec - once again 30 sec. work at 350 W - recovery /fig.1/. All of the loads have been made at 60 pedallings per minute. The overall quantity of work for entire series amounted to 8550 kgm at 8 minutes duration out of which 5 min. and 30 sec. for work and 2 min. and 30 sec. for rest intervals.

The oxygen consumption was read throughout the series and in

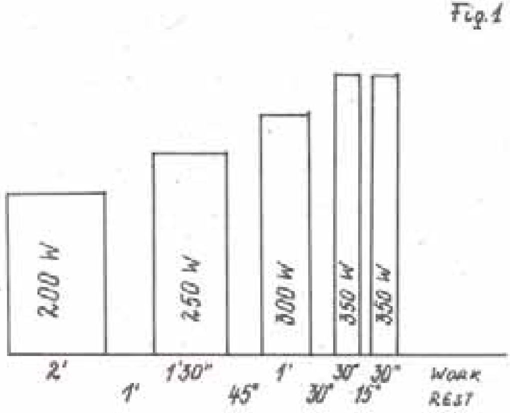

Fig. 1 Scheme of the applied interval load

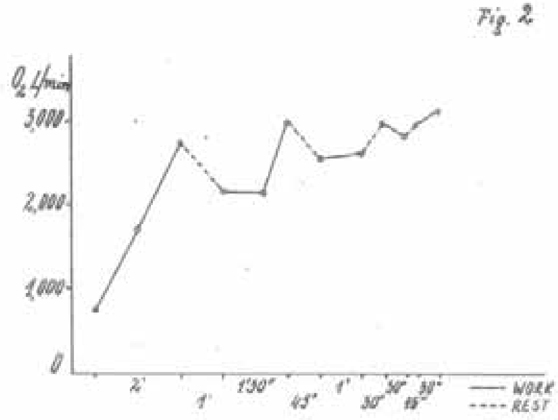

Fig. 2. O_2 consumption in litres during work and rest / in values reduced to minute/.

the first 10 minutes of the recovery by means of "Spirolyt" adapted also to MDO as well as to pulse rate readings, and on this basis the oxygen pulse rate was calculated (O_2//). At the same time, before and on the 5th minute after the end of the experiment, and on the 30-th and 60-th minute of the recovery, lactate content in venous blood was studied according to Barker and Summerson /1941/, and the acid-base balance parameters were determined: pH, pCO_2, standard bicarbonate /SB/, buffer bases /BB/ and excess bases /BE/.

Results and discussion. A steady increase of O_2 consumption was observed in each consecutive working period, unlike the interval work with equal in time and power loads where a "stable state" of O_2 consumption was usually reached after the third exertion. /D. Stefanova and L.Velevska,1972/. The O_2 consumption is increased most significantly with respect to the initial level in the first working period, where 1,702 l O_2 is consumed on the average in the first minute, and 2,743 l O_2 - in the second minute. The highest value of O_2 consumption is observed in the last 30-second working period - 3,120 l O_2 /min./ fig.2/. During rest intervals, the O_2 consumption was observed in each consecutive working period, unlike the interval work with equal in time and power loads where a "stable state" of O_2 consumption was usually reached after the third exertion. /D.Stefanova and L.Velevska,1972/. The O_2 consumption is increased most significantly with respect to the initial level in the first working period, where 1,702 l O_2 is consumed on the average in the first minute, and 2,743 l O_2 - in the second minute. The highest value of O_2 consumption is observed in the last 30-second working period - 3,120 l O_2 /min. /fig.2/. During rest intervals, the O_2 consumption restores only partially. For instance, during the first rest it drops only by 0,525 l/min relative to the second minute of the first working period. Parallel to increasing of the work intensity and shortening of the rests in the course of the experiment, the O_2 consumption is restored to a lesser degree, and in the two last rest intervals /30 and 15 sec./ it not only fails to restore, but even increases relative to the working level. Reduced to minute, the O_2 consumption at one-minute working period is 2,618 1/min., and in the 30 second rest reaches 2,448 1/min, during the next 30 sec.work - 2,808 1/min., and in the subsequent 15 second rest - 2,968 1/min.

A total of 20,0 1 O_2 /σ = 1,063/ were consumed for the series, out of which 13,655 1/σ = 0,865/ during working periods and 6,345 1/σ - 0,486/ during rest intervals.

The restoration of O_2 consumption to the initial level is relatively rapid, showing the most significant reduction between the 1st and 2nd minute - by 1,151 1. Afterwards it gradually falls by the 4th-5th minute, reaching about 0,900 1/min. Its lowering in the next 5 min. is qite insignificant, hence the difference in its drop from the 5th to 10 min. of recovery is only 0,067 1 /statistically unreliable/ /fig. 3/.

The pulse rate also shows a tendency towards continuous increase in the following periods. While in the first period it reaches 162,3 beats/ min., in the last 30-sec. working period, its maximum value is 191,6 beats/ min. Unlike the O_2 consumption during rest intervals, regardless of their duration, it always decreases relative to the preceding work /fig. 4/.

The correlations between the pulse rate reactions and O_2 consumption find an expression also in the values of the oxygen pulse rate /O_2/ p/ which during working periods ranges from 14,1 to 16,3 ml/beat, and during rest intervals it is about 17,5 ml/beat.

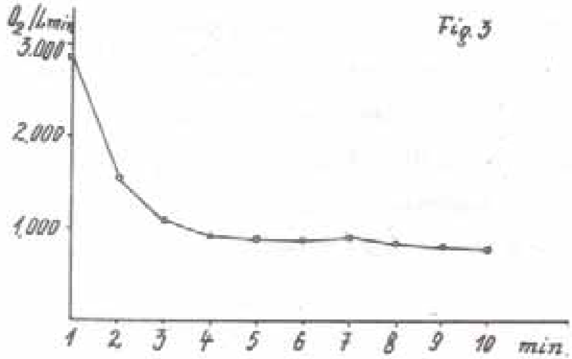

Fig. 3 Recovery of O_2 consumption after ending of the interval series

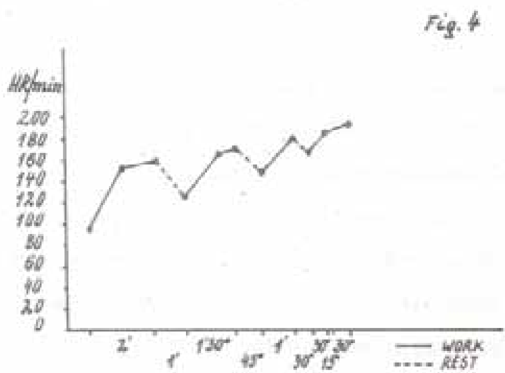

Fig. 4. Pulse rate changes at work and rest /mean values reduced to minute/

The changes in lactate concentration after adequate statistical treatment gabe us good reason to divide the experimental subjects in two groups, depending on the degree of lactate rise after exercise /fig.5/.

In the Ist group a statistically reliable lactate increase by 608,98% /P_t=0,9999/ was established on the 5th minute after exertion, as compared to the initial values. Restoration of the initial level is still absent at 30 min. after loading /P_t=0,9999/. The initial values are reached barely on the 60-th minute of the recovery.

Lactate increase by 349,92% compared to the initial values was detected in the IInd group after loading. But unlike the Ist group, its level reached the initial values already on the 30-th minute of the recovery, remaining unchanged at 60 minutes. The value differences for both groups on the 5th and 30-th minute of the recovery are statistically reliable /P_t = 0,9999/.

The investigation of the correlation between lactate concentration on the 5th minute after load and O_2 consumption for the working periods, as well of the dependence between lactate concentration and total O_2 consumption for the entire series showed some differences in both groups. A slight inversely proportional correlation was established between lactate concentration and O_2 consumption for the working periods / r = -0,29/ in the Ist group, as well as between lactate concentration and the overall O_2 consumption / r = - 0,30/. At the same time a substantial inverse correlation between lactate concentration and O_2 consumption for the working periods / r=- 0,77/, and a significant one between lactate concentration and overall O_2 consumption / r = - 0,66/ was established in the IInd group.

The causes of the different dynamics of the changes in both groups are so far unexplained.

The statistical treatment of the results from changes in the

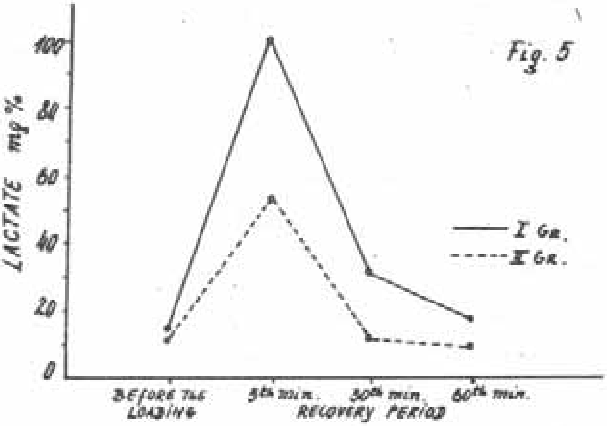

Fig. 5 Lactate cjamges during recovery period

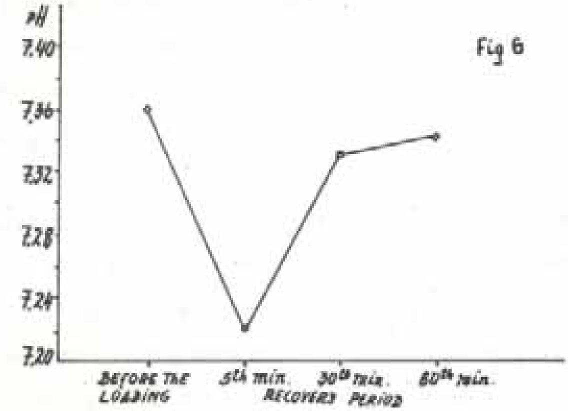

Fig. 6. Actual pH changes during recovery period

investigated parameters of acid-base balance did not warrant the differentiation of two similar groups because of the one-type character of the changes in the entire group of experimental subjects.

The actual pH /fig.6/ drops statistically reliably on the 5th min. after load by 1,90% /P_t= 0,9997/ compared to the initial values, and amounts to 7,22, failing to recover by the 30th minute after load /P_t=0,9976/ and remaining lowered by the 60-th minute /pH =7,34/.

The partial pressure of CO_2/pCO_2/ falls by 15,00% /P_t=0,9999/ after exercise /36,05 mmHg/ reaching the normal values on the 30-th minute of the recovery /fig.7/.

Standard bicarbonate /SB/ showed a decrease by 32.88% /P_t= = 0,9999, after work as compared to the initial level, and reached 15,33 mEq/l - the lowermost limit of the norm - on the 30-th minute of the recovery /fig.8/.

The buffer bases /BB/ decreased after load by 17,38% /P_t=0,9999/ compared to the initial level /fig.9/, and reached 39,19 mEq/l.

Similar changes in pCO_2, SB and BB were not observed in our laboratory when a different model of veloergometric exercises /Ye. Afar et al., 1977/ was used.

A statistically reliable fall /P_t= 0,9999/ of the bases excess /BE/ was established on the 5th minute after load /$\bar{x}$ = -12,53 ± 2,22 mEq/l/. BE reached the norm on the 60-th minute /fig.10/ of the recovery period.

The obtained data give good reason to consider that uncompensated /according to G.K.Majdrakov and D.D.Tcharaktchiev,1971/ metabolic acidosis at pH below 7,25 and fall of SB and BE is observed on the 5th minute after physical exercise. A tendency to partial compensation with pH = 7,33 and decrease of BE and SB to the lower-