SPORTS IN THE THERAPY OF INTERNAL DISEASES

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For more than ten years, an ever increasing number of physicians share the opinion that physical exercises can be of essential importance in the treatment of various internal diseases. This, however, is by no means a 'fashionable novelty'. It is generally known that in ancient times, and in the 'Golden Age' of the Roman Empire, physical exercises and sports were recommended therapeutic means described by Herodikos, Hippocrates, Galen, Philistratos and many others. During the renaissance, these thoughts were revived. In 1569, for example, Hieronimus Mercurialis, of Forli, gave detailed and accurate instructions regarding the treatment by physical exercises in his book 'De arte Gymnastica'. The same applies to Hippolitus Guarinonius, of Trient, who dealt with this subject in his German volume 'Die Greuel der Verwüstung des Menschengeschlechtes' (The Atrocity of the Devastation of Mankind). Since then, these thoughts were accentuated by outstanding scientists time and again. Heberden, in 1772, reported on the salubrity of physical exercises in the treatment of angina pectoris. Even the relevant recommendations of Parry are as old as the first description of the clinical picture which has become more than topical today.

In this respect it is the more surprising that, despite the generally acknowledged value of physical exercises, their directed use as therapeutic means still is not included in general medical routine. Consequent utilization is carried out only by few physicians and medical institutions.

Some years ago it was still possible to explain this shortcoming by saying that – although well proved – the experiences of centuries were nothing but empirical in the long run.

It could be assumed that there was no scientific foundation to justify the application of physical exercise as a specific therapeutic aim based on an adequate conception. During the last two decades, however, successful work has been carried out in the scientific exploration of the mode of action of physical conditioning and training as well as of their influence on the whole organism and its sub-systems.

Physical performance virtually depends on the coordination and integration of various biological systems. Attempts to determine the specific share of the individual systems on the overall capability are rather difficult, and in addition, complicated by the complex nature of the systems and their pronounced and variable individuality. Many of these questions may be solved only by animal experiments which, in turn, give rise to the problem of transferring these findings to the human organism. Although more detailed studies are necessary to obtain a sound foundation regarding the complex effect of physical exercises on convalescence, we may conclude that – according to Clausen – a rational physiological basis is now available for using physical exercises in the treatment of various diseases.

The increase in overall capability through consequent physical training is evident. It seems however that the extent of the rise in efficiency – apart from both intensity and scope of the training process – depends on the Wilderian Law of Original Values. The lower the initial working capacity, the higher the possible increase! With patients suffering from a severe nitroglycerine-dependent stenocardia, Kaufmann found that working capacity on the ergometer could be increased three to four times by adequate training within 3 to 4 weeks. We observed similar rises in efficiency under post-infarct conditions (Tab. 1). According to Clausen, Sheppard, Ekbloom and Hansen, the maximum oxygen uptake – as the usual parameter for assessing the overall capacity – can be increased by 30 to 40 per cent in patients showing a reduced capability, and by 10 to 20 per cent in healthy people. With the already well-trained organism of athletes, such an increase in efficiency through training frequently is only minimal, it may however, still be of deciding importance in the various cases.

Concerning the effects on the systems which contribute to increase the overall capacity it can be stated today that consistent results of clinical and experimental investigations are available. Related to problems of treating internal diseases, results in the following fields are available: Cardiovascular system, neurovegetative system, metabolism, endocrine and respiratory system. Knowledge regarding the effects of physical exercises on the psychological situation of the patient is very remarkable too.

There is no doubt that the most extensive results were obtained from studies on the cardiovascular system. Here the reduction of heart rate at rest and under exercise is the classical effect of training. It not only decreases the oxygen consumption but equally improves the diastolic blood supply (Raab, Schellhorn) and enhances the maximum stroke volume (Ekbloom,

Table 1

Working capacity and heart rate before and after physical conditioning in two groups of male postinfarct patients

Nr.	age	training days	a) clinical (step test) working capacity (watt) initial	final	b) outpatients (bicycle ergometer) Heart rate rest initial	final	exercise initial	final
13	59.4	24	65W-108"	65W-435"	77	74.2 NS	95.3	90.0+
22	61.2	40	100W-132"	100W-378"	73.2	71.4 NS	128	112.0+

NS = not significant
+ = significant (0.005)

At the end of the Physical training physical training capacity increases and heart rate decreases considerably, the difference is highly significant after exercise.

Clausen, Mushoff, Bevegaard, Cobb, Frick, Hansen). The improved cardiac efficiency caused by the mentioned functional changes is accompanied by an increased contraction power, which does not stem from an increase in enddiastolic fibre length in the sense of Starling but is due to reduced enddiastolic pressure and a lower oxygen demand (Clausen, Frick). The influence on blood circulation further improves the efficiency of the heart. Peripheral resistance is lowered via reduction of the vasomotor tone (Ekkelund) which is frequently accompanied by a general reduction of blood pressure. In addition, if the deduction from animal experimentation is allowed, consequent physical exercise leads to an increased capillarization of the myocardium and an opening of collaterals (Petren, Eckstein, Kopernick, Tittel, Burt). The function of the arterial system is also economized and the adaptability of the venous tone increased (Gadermann & Jungmann, Vassiljeva). We think to be able to support this conception with observations regarding the central pulse wave celerity in patients with cardiac diseases treated by physical exercises (Tab. 2). Owing to these effects on the

Table 2

Central pulsewave celerity

	initial	final
mean	x_a = 685.24 cm/s	x_a = 626.52 cm/s
SD	s = 58.68	
Sign.	t = 7.08 +++	

Central pulse wave celerity decreases significantly cardiovascular system consequent physical conditioning displays an excellent cardio-protective action.

To this pronounced cardio-protective effect the change in neurovegetative situation by physical training contributes very much. While acute physical exercise represents an adrenergic stimulus – which also markedly stimulates the cardiac sympathetic innervation (Rushmer) – the influence of continued physical training develops antiadrenergic predominance with reduced sympathetic tone and increased cholinergic reactions (Raab, Selye, Rajusz). This not only improves and economizes the metabolism of the heart and the contraction process (Tab. 3) but also reduces the myocardial vulnerability (Schimert, Raab). Moreover, the anti-adrenergic prevalence results in a higher resistance to the many-sided influences of stress in modern life. Recent investigations emphasize the effects of emotional stimuli on pulse rate and blood pressure (Golenhofen, Gross, Baust). Animal experiments led to the conclusion that stress situations may even give rise to atheromatous vascular alterations (Vatsade, Gruenberg), to an increased concentration of serum lipides (Krzywanek), and to hypercoagubility. Physical training, on the other hand, develops resistance even to strongly acting noxious agents (Simkin). This mechanism is an example of the so-called positive cross adaptation which also expands the anti-adrenergic capacity of the trained organism against stress-induced stimuli of a more general nature (Golenhofen). In other words, increased physical capacity also improves the overall adaptability.

The neurovegetative adaptation caused by physical training is closely related to changes in metabolism which appear during consequent physical exercise. Raab and Selye as well as Bajusz attribute them to the

Table 3

Cardiac Dynamic
Cardiac Dynamic Cycle before and after Physical Conditioning

	mean		*SD*		
	initial	*final*	*initial*	*final*	*Sign*
TP	0.157	0.133	0.019	0.02	+++
EML	0.071	0.071	0.003	0.003	0
ICP	0.086	0.062	0.018	0.024	+++
EP	0.228	0.234	0.022	0.028	+
EP/TP	1.73	1.96	0.42	0.57	++

TP = Tension Period
EP = Ejection Period
EML = Electro Mechanical Lag
ICP = Isometric Contraction Period

After physical conditioning the tension period decreases while the ejection period increases significantly resulting in an enhanced efficiency of the systole.

improvement of the intracellular electrolyte balance and to the increase of intracellular potassium in myocardial and skeletal muscles. The fact, that physical training enhances the extraction and utilization of oxygen (Doll, Saltin) is especially important. Obviously, this feature is closely related to the increase of the oxidative mitochondrial enzymes found by Holloszy in animal experiments. The resulting higher aerobic capacity (Tab. 4) enables increased lipid consumption and spares

Table 4

Blood-lactate accumulation (mmol/L)
(bicycle exercise 100 W 3') 1' post ex.

Nr.	initial	final
35	3.01	2.31
SD	0.95	0.22
Sign.	< 0.005	

As a result of enhanced cardiac efficiency and improved circulation the aerobic capacity – reflected by reduced lactic acid accumulation rises significantly after physical conditioning.

the intracellular glycogen reserve, which is reflected in the lower respiratory quotient during equal work load after physical conditioning. As verified by various authors (Akguen, Brown, Clausen, Karvonen, Montoye, Mamou, Campbell, Golding) it is possible to reduce significantly the serum cholesterol level (Tab. 5) when an adequate work load is applied. With reference to the glucose metabolism it is of special interest that – in the case of insulin deficiency – physical training increases the inhibited uptake and utilization of glucose (Goldstein, Sanders).

Table 5

Effect of physical conditioning on blood-cholesterol (mg/100 ml)

Nr.	initial	final
63	249	213
SD	49	39
Sign.	$0.01 > p > 0.005$	

As endocrine irregularities are often responsible for the development of internal diseases (Bojanowicz), it is of special interest to note that physical exercises obviously enhance the efficiency of the endocrine system especially that of the adrenal cortex. In this context we can cite numerous findings referring to an increased activity of the adrenal cortex system and its favourable structural influence (Chailley-Bert, Delane, Erez, Frenkel, Jory, Kaege, Losada, Prokop, Schoenholzer, Simkin).

Likewise, there are many other findings concerning the effects of physical training on ventilation (Clausen, Jones, Sheppard, Douglas). The functional efficiency of respiration increases mainly due to a higher respiratory volume combined with a relative decrease of the respiration rate. Moreoever, consequently applied physical exercises raise both respiration equivalent and diffusion capacity.

Finally, the psycho-therapeutic effect of physical training should not be underestimated. It is the always noticeable increase in self-reliance, combined with the conscious registration of an improved capability, on which the complex psychological factors are based which positively influence the process of recovery.

Considering these specific fundamental effects of physical training on the various functional systems, it is by no means surprising that its use in the treatment of certain diseases turned out to be a valuable measure, not only in the sense of a generally favourable medical impression, but also in compliance with stringent clinical criteria.

Extensive experience has been gained in the field of cardio-vascular diseases. The number of publications on the successful treatment of coronary heart diseases by physical conditioning is ever increasing. Some of the most representative authors are Raab, Gottheiner, Reindell, Koenig, Clausen, Frick, Halhuber, Varnauskas, Katz and Karvonen. Physical conditioning also proved to be effective after cardiac surgery (Schleusing et al.). We presented our own results in 1966 at the F.I.M.S. Congress – Hanover.

The same applies to several types of hypertension (Raab, Gottheiner, Chrasteck). Our observations agree well with these findings (Tab. 6). Physical exercises

Table 6

Effect of physical conditioning on blood pressure (mm Hg)

Nr.	initial		final	
	systol.	diastol.	systol.	diastol.
Total				
35	151.7	96.5	154.2	92.3 NS
Hypertensiv				
16	179.8	92.2	172.2 +	90.1 ++

NS = not significant
+ = significant 0.05
++ = significant 0.005

As the total represents patients with normal, hypotensive and hypertensive blood pressure the regulating effect is not visible. With the hypertensive patients alone however the decrease of systolic and especially of diastolic blood pressure is significant.

further have a favourable influence on hypotonia (Roskamm). Moreover, special designed physical exercises surely belong to the most effective therapeutic means for the often unsatisfactory treatment of peripheral circulatory diseases (Zetterquist, Heunisch, Albert, Haeger, Larssen, Schluessel, Skinner). Also in the treatment of vegetative disorders – where often a desperate medicamentous polypragmasia is applied, which drives the disappointed patient from one physician to the other – physical conditioning yields reliable effects. They are based on the described influences on the neuro-vegetative system, endocrinium, and circulation. Here it was Hochrein who, in particular, made considerable contributions.

Moreover the mentioned effects of physical training may be used with advantage for the treatment of metabolic disorders. They have proved of value in the therapy of hyperlipoidaemia and hypercholesterolaemia (Akguen and others) as well as in cases of hyperuricaemia (Moschkow et al.). In conjunction with the already described improvement in peripheral blood supply, vascular function and hypotensive effects, there are striking results in the therapy of arteriosclerosis which, unfortunately, is often treated merely symptomatical and not as a clinical entity, with a defined metabolic pathogenesis. Consequent application of physical exercise is indispensable in the treatment of diabetes mellitus. Therefore, Sanders demands that 'physical exercises must be regulated in every therapeutic programme designed to monitor the disposition of extracellular glucose'.

With various respiratory diseases, such as chronic emphysematic or asthmatic bronchitis, the therapeutic efficiency of physical exercises is also evident (Kandt and others).

Moreover, there are some reports on favourable experiences in the field of gastro-intestinal and hepatic diseases as well as special endocrine disorders. In our opinion, however, these observations are still insufficient for general conclusions.

Considering the evident and physiologically supported efficiency of physical exercises as valuable therapeutic means in the treatment of internal diseases, it is the more surprising that – as already mentioned – most physicians still hesitate to apply them consequently. We think that the main reason for this stand-offish attitude stems from the fact that it is not a matter of simply prescribing physical training. It is essential that – similar to every medication – the adequate dosage is prescribed, specifying both type and duration of the exercise in accordance with the character of the disease and adapted to the reduced degree of functional capacity.

There are often misconceptions regarding the therapeutic use of physical exercise. Now and then it is considered as a short-term affair only; competitive character is placed in the foreground, or it is aimed at a 'mass performance' without any individualization. Such

conceptions and the resulting measures are detrimental to the aims of kinesitherapy and physical conditioning. They will never yield the desired and already verified effects.

As to the dosage it should be stated that physical exercises will become effective in the described mode only if – compared to the existing level of fitness – they represent a true stimulus which is applied continuously, This demands that the training load must bear a well defined relationship to the existing working capacity.

It is further essential to adapt the mass of participating muscles to the respective situation. It need not be mentioned that the applicable degree is noticeably lower in the range of clinical therapy than with any exercises recommended for out-patients or in the prophylactic and rehabilitatory treatment of practically healthy people.

For clinical use an effective stimulus in the mentioned sense may even be the so called animated bed rest. As explained in the following table (Tab. 7), the therapeutic application of physical exercises ranges from passive influences to a relatively high physical load.

Table 7

Successive increasing load in physical conditioning with infarct patients

Inpatient

- stroke massage
- brush massage
- passive movements of arms and legs
- active movements of arms and legs (beginning with feet rolling)
- breathing exercises (initial recumbend later on sitting)
- getting up (at first for nightstool)
- walk around*
- step-training (3 x 5, 5 x 20)*

↓

Outpatient

- step-training 5x daily (stair case)
- Bicycle Ergometer 3-4x/week (dispensary)*
- walking at quick pace
- interval running
  - cycling
  - swimming
  - rowing
  - skiing

* *Careful medical control including electrocardiography immediately after performance in order to avoid complications and to determine further increase of exercise.*

The subtle estimation of the individual fitness without schematism is a virtual prerequisite for proper load dosage. This question is as difficult for prescribing physical conditioning as is the selection of the proper exercise itself. In view of the significance of assessing the functional capability, it is a deplorable fact that up to now no agreement exists with regard to the most suitable type of fitness tests; not to mention standardization of the methods as such. This emphasizes the extent of the lag which separates us from the exact natural sciences, the principles of which should be taken over more rapidly and completely. Questions like the assessment of physical capacity have been dealt with by many authors (Jones, Gottheiner and others). This also applies to the efforts of the F.I.M.S. which focused their attention on the same problem (Kral, La Cava, Larson), however, without coming to a general agreement. Obviously this is connected with the fact that the three principal regions of the assessment of physical capacity are widely different separated. In order to determine the capability of clinical cases, other methods are required than with either untrained healthy people or highly trained athletes. For this reason, we suggest that we should aim at a standardization of fitness tests based on the varying initial conditions which should be worked out by three separate groups according to these different aspects and purposes.

But even the acquirement of reliable data does not eliminate the various difficulties. Proper selection and sequence of physical exercises, and the determination of both intensity and duration, have to be based on comprehensive knowledge and experience usually found only with few physicians having dealt with this topic out of personal interest. Thus we think that, according to their significance, all questions of the therapeutic, prophylactic and metaphylactic application of physical conditioning should be already considered during pregraduate training. Similar aspects apply to the postgraduate medical education of physicians in which all these problems should be emphasized more than up to now. In some Socialist countries there is already a chair for sports medicine at the various medical faculties. In this context we can point to our experiences regarding the postgraduate education in our country in sports medicine by special courses. Moreover, in our country sports medicine is a special medical discipline. Qualification as specialist for sports medicine is acquired in a five years training following medical graduation which is concluded by an examination.

I think it necessary to mention that – apart from the previous arguments in favour of a therapeutic application – physical exercises are not only of essential economic significance but are also able to raise the relation between physician and patient to a higher ethical level.

The economic aspect is evident, considering that the

average time of hospitalization can be considerably reduced by early mobilization and functional stabilization, combined with an adequate increase in the physical capability of the patient. Although none of the conventional textbooks touch this fact, such a limitation of hospital stay to the individually justified minimum is important as clinic beds are more and more expensive and, in most of the highly developed countries, their number is declining. Apart from this, it is of great value for the psychological situation of the patient if he returns to his usual surroundings as soon as possible.

In our opinion, the high ethical value of including physical activity and sports into the therapeutic resources of every physician is manifested by the possibility of replacing certain nearly mythical relations between patient and physician – which still prevails today – by the patient's active participation in the process of recovery. This brings about a certain responsibility of the patient and gives much better prerequisites than hitherto possible with the still existing passive attitude of the patient. Moreover this establishes the fundamentals needed to improve the health-educational efficiency of the physician.

The scientific-technological revolution will cause profound changes in the entire way of living. Thus, we have to face a development where nervous stress is liable to increase. It is therefore obvious that an ever increasing percentage of the population will be subjected to the discussed detrimental stress factors.

This already conceivable trend underlines the significance of health-educational measures. It will be necessary to shift the accent of our medical aim from Asklepios to Hygieia. We should concentrate our efforts on prophylaxis and rehabilitation with special reference to diseases which must not necessarily accompany future prosperity, although they may occur through lack of attention. A physician who relies only on pure pharmacological medication deprives himself of a valuable tool. If he inludes physical exercises, his activities will change from mere prescribing to a real adjusting function. This, however, is the change from the prevailing therapeutic atitude to a prophylactic and health-educational conception and hereby stimulates the patients own responsibility and direct participation in the process of recovery.