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PREDICTORS OF PHYSICAL ACTIVITY ONE YEAR AFTER MYOCARDIAL INFARCTION

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ABSTRACT. **A number of factors predicting habitual physical activity, duration of night's rest, return to work and exercise tolerance one year after acute myocardial infarction (AMI) are studied in fifty-five male patients. Except for exercise tolerance three months after AMI, the results of this prospective study suggest that psychologic factors are more important predictors of the four outcome variables than angina pectoris, infarction size and participation in a physical training program. The most important predictor appears to be the patient's subjective opinion of his physical capabilities, measured by the perceived exercise tolerance scale. The expectation of the eventual return to work three months after MI plays also a significant role as a predictor. Both are predictors of the exercise tolerance and return to work one year after AMI. These findings suggest that physical activity—defined as exercise tolerance, habitual physical activity and duration of night's rest—and return to work are closely related.**

Key words: Myocardial infarction, physical activity, exercise tolerance, perception

Prediction of the outcome of the recovery process after myocardial infarction has been the subject of several studies. Kentala (9) analyzed the determinants of the subjective maximal working capacity and return to work in a one year follow-up. Garrity (5, 6) did the same for return to work, for return to leisure activities and for morale six months after infarction. Croog & Levine (2) did an extensive study on the one year outcome mainly in terms of patients' ratings of own progress. The studies cited have in common that return to work is used as an indicator of outcome and the result that occupational level plays a role as predictor of return to work.

In Garrity's study patients' perception of their own health status was a main predictor in all outcome variables. In the present article the one year outcome is conceptualized as 'physical activity'. The variables taken into account are: habitual physical activity, duration of night's rest and return to work as activity indicators per se and exercise tolerance as an indicator of the capacity to physical activity.

The independent variables constitute a number of relevant cardiac, psychological and social factors prior to and three months after myocardial infarction.

PATIENTS AND METHODS

The population under study was selected from male AMI patients admitted to the CCU of Leiden University Hospital. The diagnosis of AMI was made according to WHO-criteria (13). Fifty-five men could be included in this prospective study. All men were 64 years of age or under at the date of infarction. The mean age was 52 years (SD = 6.8). Not included were all patients with severe non-cardiac diseases and those patients with physical handicaps who were unable to cycle and to participate in a physical training program. In addition patients with a history of psychiatric illness were not included. After the selection the occupational distribution of the patients turned out to be somewhat restricted, medium level employee being the highest occupational level. Through a randomization procedure the patient group was divided into a physical training group (n=27) and a control group (n=28).

Physical training took place between three and six months after AMI. All patients were seen at the outpatient clinic at three, six and twelve months after AMI.

There are fourteen independent variables used in the analysis. Age, occupation and infarction size were recorded on or near the day of infarction. Angina pectoris (AP), exercise tolerance, degree of habitual physical activity, duration of night rest, extroversion, subjective load, perceived exercise tolerance and expectation of return to work were recorded at three months after AMI. In addition, the degree of physical activity and the duration of night's rest as determined in retrospect before AMI were also used as independent variables.

Whether or not the patient was in the physical training group was listed as a final independent variable. Infarction size was estimated from the maximal value of the serum lactic dehydrogenase (LDH max.). A positive diagnosis of angina pectoris was based on a history of

Table I. *Significant correlations of the independent variables with the one year outcome variables*

Independent variables	Outcome variables: Degree of activity	Duration of night's rest	Return to work	Exercise tolerance
Before AMI				
Age			−0.46	
Degree of activity	0.36			
Night's rest		0.39		
3 months after AMI				
Angina pectoris				−0.34
Exercise tolerance	0.35		0.32	0.76
Degree of activity	0.27			
Night's rest		0.40		
Extroversion		−0.28	0.35	
Subjective load		0.35	−0.47	−0.27
Perceived exercise tolerance	0.37	−0.39	0.57	0.44
Expectation of return to work			0.48	0.42

Critical value for $N=55$ and $p=0.01$: $r=0.34$; $p=0.05$: $r=0.26$.

typical pain in the chest and relief by nitroglycerine. Exercise tolerance was determined by means of bicycle ergometer with a gradually increasing load—10 Watt per minute—in a sitting position. The symptom-limited physical working capacity (Watt-max) is given as a percentage of the Watt-max expected on the basis of age, height and weight. The degree of habitual activity is estimated by a structured interview and is given as the ratio of the gross energy expenditure and the basal metabolic rate (11). The same interview was used in determining the duration of night's rest.

Extroversion was measured as a subscale of the Amsterdamse Biografische Vragenlijst (ABV) questionnaire, which is derived from Eysenck's Multiphasic Personality Inventory and calibrated on a Dutch criterion group (14). The higher the score the more extrovert a person is.

As a parameter of the patient's preoccupation with the effects of the illness the Subjective Load questionnaire was used (8). High scores—in normals a value of 12 is found—indicates high levels of subjective load. The Perceived Exercise Tolerance is a unidimensional cumulative scale measuring the patient's evaluation of his ability to perform physical activities. It consists of such simple items as being able to climb one, two or three stairs in succession, the ability of carrying a shopping bag or suitcase and a yes or no ability to run over a distance of 50 m (4). The highest score is 6, indicating that the patient is able to perform all the activities on the scale. The lowest score is 1, indicating that the patient is able to climb one stair only.

The expectation of return to work was derived from a questionnaire. It is based on a presumption of the patient that he has a fair chance of returning to work in the future. A multiple regression analysis was carried out on each of the four dependent activity variables. Two restrictions were made, first the regression coefficients in the equation had to reach at least a 5% level of significance, second no more than four variables were allowed to enter into the regression equation according to a rule of thumb from Harris (7) which states that the difference between the number of cases and the number of variables should be greater than 50. Standardized regression coefficients (β) are used for the comparison of the relative importance of the predictors. (Means, standard deviations and coding of the variables can be found in the appendix.)

RESULTS

A survey of the significant correlations between the independent or outcome variables at three months and the four outcome variables (Table I) reveals that perceived exercise tolerance at three months after AMI relates significantly with all outcome variables at one year after AMI.

Also, subjective load, exercise tolerance, extroversion and expectation of return to work and exercise tolerance seem to be potential predictors of the one year outcome. Occupation, LDH max and training or control group are not listed because of the lack of significant correlations of these factors with the four outcome variables. The results of the multiple regression analysis in Table II show that the degree of activity before AMI and perceived exercise tolerance at three months after AMI are equivalent determinants of the degree of activity one year after AMI (the β-coefficients are equal). The duration of night's rest one year after AMI is mainly determined by the preceding values of this variable. Here too perceived exercise tolerance plays a role as predictor. For return to work per-

Table II. *Results of regression analysis on one year outcome variables*

Dependent variables	Predictors	Zero-order r	β
Degree of activity	1. Perceived excercise tolerance 3 months	0.37	0.37
	2. Degree of activity before AMI	0.36	0.36
	$R=0.49, p<0.01$		
Duration of night's rest	1 Duration of night's rest 3 months	0.40	0.32
	2. Duration of night's rest before AMI	0.39	0.40
	3. Perceived exercise tolerance 3 months	−0.39	−0.34
	$R=0.62, p<0.01$		
Return to work	1. Perceived exercise tolerance 3 months	0.57	0.41
	2. Age	−0.46	−0.29
	3. Expectation of return to work	0.48	0.28
	$R=0.69, p<0.01$		
Exercise tolerance	1. Exercise tolerance 3 months	0.76	0.70
	2. Expectation of return to work	0.42	0.23
	$R=0.78, p<0.01$		
Exercise tolerance (without 3 months value)	1. Expectation of return to work	0.42	0.32
	2. Angina pectoris 3 months	−0.34	−0.26
	3. Perceived exercise tolerance 3 months	0.44	0.27
	$R=0.56, p<0.01$		

All β's are significant at at least 5% level. The zero-order r's are the correlations of a predictor and a dependent variable.

ceived exercise tolerance three months after AMI appears to be the most important predictor although expectation of return to work and the perceived exercise tolerance are—as is to be expected—positively related; the correlation however is not very high ($r=0.31$). Exercise tolerance twelve months after AMI is especially determined by that at three months.

When we omit the three months value of exercise tolerance from the analysis other variables get opportunity to enter in the regression equation. It then appears that the expectation of return to work, angina pectoris and again perceived exercise tolerance, have modest values as predictors. It is worth noticing that infarction size, physical training program and occupation do not play a role as predictor of one year outcome variables.

The overall impression of the results is that the assessment of patient's own exercise tolerance as measured by the perceived exercise tolerance-scale at three months after AMI is a rather firm predictor of the one year outcome. The apparent consistency of the perceived exercise tolerance as a predictor can further be tested by means of a jackknifing procedure. Advantage is taken here from the fact that the patient group was randomly split up into a training group and a control group. The stability of the single order correlations between perceived exercise tolerance and the four dependent variables is tested by comparing the correlations in training and control group. As can be seen from Table III, the correlations have all the same direction and are significant except for exercise tolerance and degree of activity in the training group.

However, although perceived exercise tolerance acts as a good predictor of the outcome variables, this does not mean that it exerts its influence directly on these variables. The correlations of perceived exercise tolerance with any outcome variable might change when the interrelations of the outcome variables are taken into account.

When we assume perceived exercise tolerance

Table III. *Pearson correlations perceived exercise tolerance 3 months after AMI with one year outcome variables in training and control group*

	Training group ($n=27$)	Control group ($n=28$)
Degree of activity	0.37	0.38
Duration of night's rest	−0.40	−0.43
Return to work	0.44	0.69
Exercise tolerance	0.35	0.52

Critical value for 5% significance, $r=0.38$.

Table IV. *Zero-order and partial correlations between perceived exercise tolerance at 3 months and the 4 outcome variables 12 months after AMI (n=55).*

Perceived exercise tolerance 3 months	Zero-order r	Third order r^a	p
Degree of activity	.37	.23	>.10
Duration of night's rest	−.39	−.10	>.10
Return to work	.57	.43	<.01
Exercise tolerance	.44	.11	>.10

[a] Three remaining outcome variables are controlled.

at three months to be the single predictor and control statistically for these interrelations by partial correlations (Table IV), the only correlation maintaining a significant level is that between perceived exercise tolerance and return to work.

DISCUSSION

Clearly, five independent variables show significant correlations with more than one outcome variable, exercise tolerance at three months being the only physical factor among four psychological measures. The absence of any relation between the LDH max—an indicator of the infarct size—and the exercise tolerance one year after the AMI requires some explanation. A possible explanation for the apparent lack of a relationship might be the absence of patients with large myocardial infarctions in our study. The literature, however, is equivocal on this subject. Carter & Amundsen (1) found a negative relationship but Davidson & De Busk (3) could not find any relationship between the two. The absence of a significant correlation between occupational level and return to work might be attributed to the restricted distribution of occupations, medium level employees being the highest level. However, there is correlational evidence that , at least in this study, occupation acts indirectly on return to work via subjective load and perceived exercise tolerance.

The multiple regression analysis shows that some potential predictors like subjective load and extroversion further play no role whatsoever. Exercise tolerance one year after AMI appears to be highly related to exercise tolerance three months after AMI in accordance with Kentala's findings (9). Exercise tolerance three months after AMI and notably expectation of return to work provide together the highest multiple correlation coefficient in the prediction of exercise tolerance one year after AMI.

Return to work is best predicted by perceived exercise tolerance, expectation of return to work at three months and by age.

It is worth noticing that the relationship between perceived exercise tolerance and return to work is even stronger than that between expectation of return to work and actual return to work. On the face of it, considering the essential congeniality between expectation of return to work and actual return the reverse should be more plausible. It seems however very probable that both variables have to be regarded as indicators of the optimism of the patient as to his physical capabilities in view of the predictive value of the expectation of return to work for the exercise tolerance one year after AMI. The most important finding is the fact that the subjective opinion of the patient on his physical capability three months after AMI as measured by the perceived exercise tolerance scale is apparently a rather consistent and relatively stable predictor of the one year outcome. This is in agreement with Garrity's findings (5, 6). This author found that 'health perception' did best predict 'morale' and return to work. Monteiro (10) likewise showed that the severity of the heart attack as has been perceived by the patient acted as the most important predictor of return to work.

In the present study the recovery after myocardial infarction has been regarded in the context of the physical activity concept (12). At first, it seems not very plausible that return to work should be essentially connected with the physical activity concept. The results presented here, however suggest a strong relationship between physical activity and return to work.

Garrity's finding that psychological factors are more important predictors of return to work than medical and physical ones has been confirmed by our study. In fact the subjective opinion of the patient on his physical capabilities and on the prospects to resume work apparently influence the eventual return to work.

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Appendix. *Means and standard deviations of variables in regression analysis*

Independent variables						Dependent variables		
AMI	$\bar{X}$	(SD)	3 months after AMI	$\bar{X}$	(SD)	12 months after AMI	$\bar{X}$	(SD)
Night's rest (h)	7.2	(1.0)	Night's rest (h)	9.3	(1.0)	Night's rest (h)	8.6	(1.2)
Degree of activity	2.34	(0.5)	Degree of activity	1.79	(0.2)	Degree of activity	1.93	(0.4)
Occupation[a]	1.8	(0.9)	Exercise tolerance[b]	93.6	(14.6)	Exercise tolerance[b]	100.6	(17.4)
Age	52.2	(6.8)	Expectation of return to work[c]	0.5	(0.5)	Return to work[d]	0.8	(0.8)
LDH max (U/l)	461.6	(218.3)	Angina pectoris[e]	0.3	(0.5)			
			Perceived exercise tolerance	3.5	(1.6)			
			Subjective load	22.2	(10.9)			
			Extroversion	53.7	(15.1)			
			Training or control group[f]	0.5	(0.5)			

[a] Code: 1= (un-) skilled labour, 2= self-employed in small business, 3= higher occupation.
[b] % of predicted value.
[c] Code: 0=Pessimistic, 1= optimistic.
[d] Code: o=none, 1= part-time, 2=full-time.
[e] Code: 0= negative or dubious, 1= positive.
[f] Code: 0= control group, 1= training group.

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