

# Knowledge on cardiovascular risk factors improves the effectiveness of rehabilitation following acute coronary syndrome

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## Abstract

**Background:** There is a clear association between knowledge on healthy lifestyle and intensity of healthy behaviours, especially among young people.

**Aim:** We sought to verify this hypothesis among patients after acute coronary syndrome (ACS), who were subjected to early in-hospital complex cardiac rehabilitation (CCR), by assessing the relationship between initial knowledge on cardiovascular risk factors and efficiency of rehabilitation.

**Methods:** Two hundred and five consecutive patients (153 men; age  $62 \pm 9$  years) hospitalised between May 2013 and April 2014 were prospectively enrolled. On admission, the knowledge on risk factors was assessed by questionnaire. At the beginning, in the second and in the third week of CCR the six-minute walk test (6MWT) was performed. Effectiveness of rehabilitation was assessed by the 6MWT in the third week. Distance, speed, and metabolic equivalents (METs) were considered markers of improvement.

**Results:** The most common number of correct answers was 11 (out of 20 questions) about risk factors (on average  $54 \pm 18\%$ ). Knowledge on more than 10 items was found for 99 subjects (48%) (i.e. good level of knowledge). Improvement of haemodynamic parameters and CCR effectiveness was found ('0' vs. '3': distance [m]:  $442.0 \pm 102.2$  vs.  $485.2 \pm 109.3$ ,  $p < 0.01$ ; speed [km/h]:  $4.4 \pm 1.0$  vs.  $4.8 \pm 1.1$ ,  $p < 0.01$ ; METs:  $3.1 \pm 0.5$  vs.  $3.3 \pm 0.5$ ;  $p < 0.01$ ). Significantly better indicators of CCR effectiveness characterised patients with better knowledge (good knowledge vs. bad knowledge: distance [m]:  $500.5 \pm 95.7$  vs.  $470.8 \pm 119.4$ ,  $p = 0.04$ ; speed [km/h]:  $5.0 \pm 1.0$  vs.  $4.7 \pm 1.2$ ,  $p = 0.04$ ; METs:  $3.4 \pm 0.5$  vs.  $3.2 \pm 0.6$ ,  $p = 0.04$ ). There was correlation between the percentage of correct answers and distance in 6MWT ( $R = 0.374$ ,  $p < 0.001$ ).

**Conclusions:** Knowledge on the cardiovascular risk factors improves rehabilitation effectiveness among patients after ACS.

**Key words:** acute coronary syndrome, secondary prevention, knowledge, rehabilitation

Kardiol Pol 2017; 75, 4: 344–350

## INTRODUCTION

The results of complex cardiac rehabilitation (CCR) are well known and scientifically documented, and they include: reduced risk of death, especially from cardiovascular (CV) causes, and improvement of the quality of life with possibility of fast return to social and professional activity due to better physical condition and general psychomotor performance

[1–3]. From a pathophysiological point of view those positive effects result from a decrease in tension of the sympathetic system, and improvement in the vascular endothelium function and rheology of the blood [4–6].

Knowledge on CV risk factors is an essential part of efficient and permanent modification of patients' habits concerning diet, physical activity, and addictions [7]. There is positive

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Received: 16.08.2016

Accepted: 29.11.2016

Available as AoP: 27.12.2016

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correlation between high level of self-awareness and patients' attitudes to comply with guidelines of secondary prevention [8–10]. It is also known that physically active people, independently from demographic and socio-economic factors, are more aware of choosing proper behaviours, especially about diet and stimulants [11]. Better knowledge and awareness on primary or secondary prevention and health promotion practices is also characteristic for this group [11].

Therefore, we sought to investigate the relationship between baseline knowledge on CV risk factors and effectiveness of cardiac rehabilitation in patients after acute coronary syndrome (ACS) treated with percutaneous intervention.

## METHODS

### Study group

We prospectively enrolled 205 consecutive patients following ACS treated with percutaneous intervention, undergoing early in-hospital CCR during the period 05.2013–04.2014. Basic inclusion criterion was qualification and ability to participate in CCR. Exclusion criteria were: physical disability that made participation in rehabilitation procedures impossible (e.g. state after amputation, significant degree of osteoarthritis, uncontrolled chronic obstructive pulmonary disease), disability making filling out the questionnaire and educational materials unassisted impossible (e.g. considerable amblyopia despite the correction of the vision defects), intellectual disability making filling out questionnaire unassisted impossible, incomplete rehabilitation cycle, or lack of patient consent.

### Complex cardiac rehabilitation programme

Complex cardiac rehabilitation was performed according to the guidelines of the Section of Rehabilitation of the Polish Cardiac Society [12]. A full exercise plan included endurance training, kinesiotherapy, and physiotherapy. At the beginning, in the second, and in the third week of the CCR cycle all subjects underwent a six-minute walk test (6MWT). Effectiveness of rehabilitation was assessed based on results of the 6MWT in the third week of CCR (haemodynamic parameters were considered indicators of cardio-pulmonary fitness and distance; speed and metabolic equivalents (METs) were considered markers of physical improvement).

### Knowledge about cardiovascular risk factors

Knowledge on CV risk factors was assessed with the use of an author-based questionnaire prepared according to the Guidelines of the Polish Circulatory System Diseases Prevention Forum [13]. Good (high) knowledge was defined as at least 50% correct answers in the tool. Additional information was obtained from anamnesis and standard medical data on admission to the hospital. Before that, the questionnaire underwent a procedure of validation using 'test' — 'retest' method, which confirmed its credibility (i.e. it was distributed among 105 randomly selected subjects on hospital admission, and the same tool was distributed again after seven days). The

repeatability was within the range 0.9–1.0, and the kappa statistics was within the range 0.82–1.0.

Patient confidentiality was ensured because the dataset was fully anonymised. The project was approved by the Bioethics Committee.

### Statistical analysis

Statistical analysis was performed using MedCalc Statistical Software version 14.8.1 (MedCalc Software bvba, Ostend, Belgium). Continuous variables are expressed as median and interquartile range (IQR; 25–75 pc). Qualitative variables are expressed as absolute values and percentage. Between-group differences for quantitative variables were assessed using student t-test or Mann-Whitney U-test. Previously, the type of distribution was verified using Shapiro-Wilk test. For qualitative data the  $\chi^2$  test was used. Correlation was determined by the use of Spearman rank coefficient. A p value < 0.05 was considered significant.

## RESULTS

The study group comprised 205 patients (153 man and 52 woman) aged  $62 \pm 9$  years. Baseline characteristics of the subjects, with distinction between those with high and low knowledge, are shown in Table 1.

The results of 6MWT (baseline and follow-up values) are shown in Table 2. Patients statistically significantly improved in terms of haemodynamic parameters and physical condition. Noticeable progress in terms of distance (in metres) was found during the whole CCR cycle ('0':  $442.0 \pm 102.2$  vs. '2 weeks':  $467.8 \pm 104.3$  vs. '3 weeks':  $485.2 \pm 109.3$ ;  $p < 0.001$ ).

In 20 questions on risk factors and healthy behaviours, subjects showed the best knowledge on overweight/obesity and smoking habit (Table 3). Eleven correct answers was the most common result ( $54 \pm 18\%$  on average), and knowledge on more than 10 items (i.e.  $\geq 50\%$ ) was found for 99 (48%) subjects (Fig. 1), which was recognised as good knowledge for further analyses.

Significantly better indicators of CCR effectiveness characterised patients with better knowledge (good knowledge vs. bad knowledge: distance [m]:  $500.5 \pm 95.7$  vs.  $470.8 \pm 119.4$ ,  $p = 0.04$ ; speed [km/h]:  $5.0 \pm 1.0$  vs.  $4.7 \pm 1.2$ ,  $p = 0.04$ ; METs:  $3.4 \pm 0.5$  vs.  $3.2 \pm 0.6$ ,  $p = 0.04$ ) (Table 4). Moreover, all time-dependent changes in studied parameters altered significantly, with more improvement observed in subjects with better knowledge. There was substantial correlation between the percentage of correct answers in the questionnaire and distance in 6MWT ( $R = 0.374$ ;  $p < 0.001$ ).

## DISCUSSION

There is a clear association between knowledge on healthy lifestyle and intensity of healthy behaviours, especially among young people. We decided to verify this hypothesis in subjects after ACS scheduled to early in-hospital CCR. Our study, despite its simplicity, shows that patients with better knowledge

Table 1. Study group characteristics

Variable	Total	Knowledge (-)	Knowledge (+)	p
Male gender	153 (75%)	81 (76%)	72 (73%)	0.65
Age [years]	62 ± 9	65 ± 8	62 ± 10	0.02
Education:				0.12
Primary school level	107 (52%)	62 (58%)	45 (45.5%)	
Secondary school level	69 (34%)	32 (30%)	37 (37.5%)	
College level	10 (5%)	6 (6%)	4 (4%)	
University level	19 (9%)	6 (6%)	13 (13%)	
Body mass index [kg/m <sup>2</sup> ]	29 ± 4	28 ± 4	28 ± 4	0.27
Obesity (BMI ≥ 30 kg/m <sup>2</sup> )	72 (35%)	40 (38%)	32 (32%)	0.41
Type of obesity:				0.81
WHR ≥ 1	48 (68%)	28 (70%)	20 (62.5%)	
WHR < 1	24 (32%)	12 (30%)	12 (37.5%)	
Smoking habit	71 (35%)	40 (38%)	31 (31%)	0.41
Smoking – pack-years	16 ± 8	14 ± 4	16 ± 4	0.17
Low physical activity*	36 (18%)	20 (19%)	16 (16%)	0.74
Arterial hypertension	154 (75%)	78 (74%)	76 (76%)	0.72
Diabetes	56 (27%)	31 (28%)	25 (25%)	0.74
Form of treatment of diabetes:				0.66
Diet only	17 (30%)	8 (26%)	9 (36%)	
Oral medications	28 (50%)	16 (52%)	12 (48%)	
Insulin	11 (20%)	7 (22%)	4 (16%)	
Dyslipidaemia	100 (49%)	52 (49%)	48 (48%)	0.95
Family history of cardiovascular diseases	127 (62%)	57 (54%)	70 (70%)	0.02

\*i.e. less than 30 minutes of moderate physical activity (fast walking, cycling, aerobic, swimming, etc.) in less than 4 days during week; BMI — body mass index; WHR — waist-to-hip ratio

Table 2. Results of a six-minute walk test at baseline and after three weeks of rehabilitation

Parameter	Baseline	After three weeks	Difference	p
Resting HR [1/min]	68.5 ± 8.5	69.2 ± 7.9	0.73 ± 6.4	0.13
Peak HR [1/min]	75.8 ± 10.7	77.8 ± 10.9	2.0 ± 8.8	< 0.01
Resting SBP [mm Hg]	129.4 ± 15.2	127.2 ± 14.0	-2.2 ± 14.5	0.15
Resting DBP [mm Hg]	79.1 ± 9.8	78.0 ± 9.6	-1.2 ± 9.2	0.08
Peak SBP [mm Hg]	139.0 ± 18.2	139.4 ± 16.8	0.4 ± 17.6	0.08
Peak DBP [mm Hg]	83.1 ± 10.8	83.6 ± 10.4	0.5 ± 9.7	0.11
Distance [m]	442.0 ± 102.2	485.2 ± 109.3	43.2 ± 70.6	< 0.01
Speed [km/h]	4.4 ± 1.0	4.8 ± 1.1	0.4 ± 0.7	< 0.01
Borg scale	11.9 ± 1.1	11.6 ± 1.1	-0.3 ± 1.0	< 0.01
Metabolic equivalents (METs)	3.1 ± 0.5	3.3 ± 0.5	0.2 ± 0.3	< 0.01

HR — heart rate; DBP — diastolic blood pressure; SBP — systolic blood pressure

on CV risk factors do better in rehabilitation. It may become an important issue while organising and programming cardiac rehabilitation cycles for patients after myocardial infarction [14, 15]. An Individualised approach in education about proper healthy behaviours, burden, and risk factors of CV

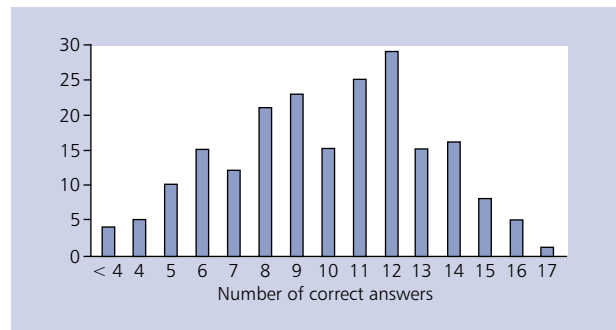
diseases should become its permanent and important elements [14, 15]. Coordinated care after myocardial infarction should consist of four modules: complete revascularisation, education and rehabilitation programme, electrotherapy, and periodical cardiac consultations. At the first stage the coordi-

**Table 3.** Knowledge on cardiovascular risk factors

Is this a cardiovascular risk factor?	Correct answer
Excessive body weight (overweight/obesity)	184 (90%)
Older age	78 (38%)
Osteoporosis	72 (35%)
Male gender	35 (17%)
Height	86 (42%)
Intake of vegetable fats	54 (26%)
Hypertension	153 (75%)
Excessive physical training	60 (29%)
Cigarette smoking	181 (88%)
Pipe smoking	140 (68%)
Diabetes	135 (66%)
Peptic ulcer disease	67 (33%)
High cholesterol level	157 (77%)
Low level of HDL-C	31 (15%)
Common stress	165 (80%)
Depression	15 (7%)
Environment pollution	86 (42%)
Family history of heart diseases	134 (65%)
Lack of physical activity	142 (69%)
Family history of a stroke	55 (27%)

HDL-C — high-density lipoprotein cholesterol

nated care programme should last for 12 months. Moreover, the quality of care assessment based on clinical measures, including risk factor control, rate of complete myocardial



**Figure 1.** Knowledge on cardiovascular risk factors as number of correct answers in a 20-item questionnaire

revascularisation, as well as on the rate of CV events, should be performed [15].

Unfortunately, in everyday practise only a small number of patients after ACS attend early CCR in the hospital environment [16, 17]. Only a few from this group decide to continue rehabilitation in ambulatory programmes [18]. Comfort, accessibility, the psychological and socio-economical profile of the subjects, and other certain patient-related issues (e.g. smoking habit) are some of the reasons for this situation [18, 19]. In our study the demographic and clinical profile of the subjects was comparable to that described in numerous papers on knowledge on CV risk factors and secondary prevention [20–22]. Therefore, we may assume that our findings are representative for the population.

The control of CV risk factors in Polish patients after myocardial infarction remains insufficient [15] and has not im-

**Table 4.** Results of a six-minute walk test at the end of rehabilitation and the changes in parameters from baseline to the end of the rehabilitation by knowledge category on cardio-vascular risk factors

Parameter	Knowledge (-)		Knowledge (+)		p for difference in absolute values	p for difference in time period
	Absolute values (after 3 weeks)	Difference in values after 3 weeks — at baseline	Absolute values (after 3 weeks)	Difference in values after 3 weeks — at baseline		
Resting HR [1/min]	69.5 ± 8.1	1.7 ± 6.3	68.8 ± 7.7	-0.3 ± 6.3	0.55	0.02
Peak HR [1/min]	78.5 ± 11.0	3.2 ± 9.4	77.1 ± 10.7	0.4 ± 6.4	0.46	0.02
Resting SBP [mm Hg]	129.3 ± 13.9	1.2 ± 12.7	124.7 ± 13.7	-5.8 ± 15.4	0.01	< 0.001
Resting DBP [mm Hg]	78.0 ± 10.3	-0.3 ± 9.2	78.0 ± 8.8	-2.1 ± 9.2	0.98	0.07
Peak SBP [mm Hg]	140.6 ± 19.2	3.5 ± 17.7	138.1 ± 13.8	-3.1 ± 16.8	0.74	0.02
Peak DBP [mm Hg]	83.8 ± 12.1	1.8 ± 8.9	83.4 ± 8.1	-0.9 ± 10.2	0.64	0.02
Distance [m]	470.8 ± 119.4	55.8 ± 69.5	500.5 ± 95.7	29.5 ± 69.5	0.04	0.001
Speed [km/h]	4.7 ± 1.2	0.6 ± 0.7	5.0 ± 1.0	0.3 ± 0.7	0.04	0.001
Borg scale	11.7 ± 1.2	-0.3 ± 1.0	11.5 ± 0.9	-0.2 ± 1.0	0.06	0.1
Metabolic equivalents [METs]	3.2 ± 0.6	0.3 ± 0.3	3.4 ± 0.5	0.1 ± 0.3	0.04	0.001

HR — heart rate; DBP — diastolic blood pressure; SBP — systolic blood pressure

proved markedly in the last 20 years. According to the Cracovian Programme for Secondary Prevention of Ischaemic Heart Disease, the proportion of patients with adequate control of all major risk factors in patients one year after hospitalisation due to ischaemic heart disease is only 9% [23]. Moreover, in the nationwide POL-AMI database it was found that during one year after myocardial infarction only 22% of patients were subjected to cardiac rehabilitation, mostly during the first three months after acute myocardial infarction (79% of them) [24].

Physical activity following coronary syndromes improves physical fitness, cardio-metabolic profile, and, combined with adequate diet, efficiently reduces body mass and has a beneficial effect on psycho-social condition as well as quality of life [25–28]. This effect is dependent on the type of training, its intensity, duration of the programme, and effect assessment methods [29, 30]. In our study we intentionally used a simple 6MWT for assessing physical condition. This widely used, standardised method is well tolerated by patients, and its rules are easy to understand, even for older people. Moreover, the 6MWT can be guided by a physiotherapist without direct physician supervision in almost every hospital environment. What is most important, it may be repeated during the hospitalisation to eliminate the learning curve and to observe the real progress of rehabilitation. Implementation of cardiopulmonary exercise testing with the use of ergospirometry or treadmill test is usually theoretically and practically limited (although it gives more reliable results).

A direct comparison of our results to literature data is quite difficult because of the novelty of our project. A lot of valuable information may be found in a paper by Turner et al. [25] based on a group of 1443 patients aged  $60 \pm 10$  years, who demonstrated a significant improvement of oxygen absorption during treadmill test of  $3.2 \text{ mL/min/kg}$  (95% CI 3.1–3.4), and in a paper by Lavie et al. [26] based on 104 patients aged  $48 \pm 6$  years, who showed an 11.3% improvement in oxygen absorption during endurance test. The results of Gołuchowska et al. [27] are also of interest, who documented progress of cardio-pulmonary fitness after a two-month cycle of rehabilitation within a group of 63 men after percutaneous coronary intervention; in training on bicycle ergometer Ppeak increased from  $94.21 \pm 16.94 \text{ W}$  to  $119.97 \pm 19.43 \text{ W}$ , while peak heart rate decreased from  $119.97 \pm 19.43 \text{ bpm}$  to  $108.25 \pm 13.36 \text{ bpm}$ . Unfortunately, neither of those studies compares the results in terms of knowledge on CV risk factors.

### Limitations of the study

Our research has several limitations. First, it is an observational epidemiological study performed within one rehabilitation centre, so uncritical extrapolation of the results onto a larger population is impossible without being exposed to bias. Second, both methods we used to gather data may be burdened with measurement error. However, we tried to overcome this drawback by using a validation procedure in the question-

naire and retaking 6MWT three times. Third, our statistical methods did not cover multivariate analysis, so the influence of confounders cannot be eliminated.

## CONCLUSIONS

Knowledge on CV risk factors is associated with effectiveness of rehabilitation.

**Conflict of interest:** none declared

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**Cite this article as:** Kapko WS, Krzych Ł. Knowledge on cardiovascular risk factors improves the effectiveness of rehabilitation following acute coronary syndrome. *Kardiologia Pol.* 2017; 75(4): 344–350, doi: [10.5603/KP.a2016.0188](https://doi.org/10.5603/KP.a2016.0188).

# Znajomość czynników ryzyka sercowo-naczyniowego poprawia skuteczność rehabilitacji u chorych po ostrym incydencie wieńcowym

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## Streszczenie

**Wstęp:** Efekty kompleksowej rehabilitacji kardiologicznej (CCR) są dobrze znane i opisane; obejmują zmniejszenie ryzyka zgonu, zwłaszcza z przyczyn sercowo-naczyniowych, poprawę jakości życia z możliwością szybkiego powrotu do życia społecznego i zawodowego, co wynika przede wszystkim z lepszej wydolności fizycznej oraz ogólnej sprawności psychoruchowej. Udokumentowano, że istnieje współzależność między wiedzą na temat zdrowego stylu życia a intensywnością zachowań jemu sprzyjających, zwłaszcza u osób młodych.

**Cel:** Celem pracy było zweryfikowanie tej hipotezy u chorych po ostrym incydencie wieńcowym poddawanych wczesnej stacjonarnej CCR, oceniając związek między wyjściową znajomością czynników ryzyka sercowo-naczyniowego a skutecznością rehabilitacji.

**Metody:** Prospektywną obserwacją objęto 205 kolejnych chorych (153 mężczyzn i 52 kobiety, w wieku  $62 \pm 9$  lat) hospitalizowanych w okresie 05.2013–04.2014. Kryterium włączenia była kwalifikacja do i chęć udziału w CCR. Kryteria wyłączenia stanowiły: niepełnosprawność fizyczna uniemożliwiająca udział we wszystkich etapach/procedurach rehabilitacji, niepełnosprawność uniemożliwiająca samodzielne wypełnienie kwestionariusza oraz korzystanie z materiałów edukacyjnych, niepełnosprawność intelektualna uniemożliwiająca samodzielne wypełnienie kwestionariusza, niepełny cykl rehabilitacji oraz brak zgody badanego. Znajomość czynników ryzyka sercowo-naczyniowego oceniano w kwestionariuszu przy przyjęciu. Kwestionariusz poddano uprzednio procedurze walidacji. Na początku, w drugim i trzecim tygodniu cyklu przeprowadzono 6-minutowy test korytarzowy. Efektywność rehabilitacji oceniano na podstawie osiąganych wyników w teście w trzecim tygodniu pobytu (parametry hemodynamiczne jako wykładniki wydolności krążeniowej oraz dystans, prędkość i równoważniki metaboliczne jako parametry skuteczności rehabilitacji).

**Wyniki:** W 20 pytaniach o znajomość poszczególnych czynników ryzyka badani najczęściej wskazywali 11 poprawnych odpowiedzi (średnio  $54 \pm 18\%$ ). Znajomością więcej niż 10 czynników ryzyka cechowało się 99 (48%) badanych, co przyjęto jako dobry poziom wiedzy. Pacjenci uzyskali znamienne poprawę w zakresie parametrów hemodynamicznych (wysiłkowe szczytowe tętno i ciśnienie tętnicze) oraz wskaźników skuteczności rehabilitacji ('0' vs. '3': dystans [m]:  $442,0 \pm 102,2$  vs.  $485,2 \pm 109,3$ ;  $p < 0,01$ ; prędkość [km/h]:  $4,4 \pm 1,0$  vs.  $4,8 \pm 1,1$ ;  $p < 0,01$ ; równoważniki metaboliczne [MET]:  $3,1 \pm 0,5$  vs.  $3,3 \pm 0,5$ ;  $p < 0,01$ ). Osoby z lepszą wiedzą cechowały się znamienne lepszymi wskaźnikami skuteczności rehabilitacji (dobra wiedza vs. zła wiedza: dystans [m]:  $500,5 \pm 95,7$  vs.  $470,8 \pm 119,4$ ;  $p = 0,04$ ; prędkość [km/h]:  $5,0 \pm 1,0$  vs.  $4,7 \pm 1,2$ ;  $p = 0,04$ ; równoważniki metaboliczne [MET]:  $3,4 \pm 0,5$  vs.  $3,2 \pm 0,6$ ;  $p = 0,04$ ). Stwierdzono istotną korelację między odsetkiem prawidłowych odpowiedzi w kwestionariuszu a przebyty dystansem w teście korytarzowym ( $R = 0,374$ ;  $p < 0,001$ ).

**Wnioski:** Znajomość czynników ryzyka sercowo-naczyniowego poprawia skuteczność rehabilitacji u chorych po ostrym incydencie wieńcowym. Dlatego też należy podejmować i indywidualizować działania w zakresie edukacji prozdrowotnej i zwiększania świadomości chorych po ostrym incydencie wieńcowym w zakresie prewencji wtórnej.

**Słowa kluczowe:** ostry zespół wieńcowy, prewencja wtórna, wiedza, rehabilitacja

Kardiologia 2017; 75, 4: 344–350

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Praca wpłynęła: 16.08.2016 r.

Zaakceptowana do druku: 29.11.2016 r.

Data publikacji AoP: 27.12.2016 r.