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Cardiac Rehabilitation in the Elderly Patients

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Abstract

Cardiac rehabilitation for elderly patient is a growing needs because as people age the prevalence of cardiovascular disease increase. A more vulnerable population is now present in cardiac rehabilitation because they are more likely to be frail. Frailty is considered highly prevalent and heterogeneous in its level of expression. Following hospitalization for an event such as acute coronary syndrome or heart failure decompensation, all patients, and in particular the elderly, are at increased risk of instabilization, new cardiovascular events and disability. The efficacy and safety of cardiac rehabilitation have been widely demonstrated also in the elderly patients with stable coronary heart disease or those who have undergone myocardial revascularization with percutaneous coronary intervention, coronary artery bypass graft surgery and heart failure. Cardiac rehabilitation programs are designed to enhance recovery from acute cardiovascular events and to improve both quality of life and survival by means of measure of secondary prevention–physical activity, diet, risk factors control and medical treatment optimization. Accumulating evidence has shown comparable exercise training benefits in older and younger patients. The use of cardiac rehabilitation programs in the elderly should be based on Comprehensive Geriatric Assessment in which different domains needs to be assessed with a definite rehabilitation program driven by the specific disability and not only related to disease. Special attention should be posed to frail elderly patients in whom a personalized intervention is necessary. In details will be described rehabilitation protocols for elderly based on prevalent disability status.

Keywords: Cardiac rehabilitation; Elderly; Disability; Complexity

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Introduction

Cardiac rehabilitation (CR) is a complex intervention offered to patients with heart disease, which includes components of health education, advice on cardiovascular risk reduction, physical activity and stress management. Cardiac rehabilitation reduces mortality (27% reduction in all-cause mortality and 31% reduction in CHD mortality), morbidity, and unplanned hospital admissions in addition to improvements in exercise capacity, quality of life and psychological well-being [1]. Current indication for CR are the following: Post-Myocardial Infarction (MI), Post-Coronary Artery By-pass Grafting (CABG), Angina, Percutaneous Coronary Intervention (PCI), Valve replacement or repair, Heart transplant, Heart Failure(HF) II-III New York Heart Association (NYHA) class and recently also end stage HF and Left Ventricular Assisting Device (LVAD) implant [1]. In the recent years, patients admitted to CR are characterized by a growing clinical instability, with a complex co-morbidity scenario due to the aging process and the unsolved acute phase of the disease that require the need of rehabilitation [2,3]. In a short period of years, in all western countries, there has been a radical change in the rehabilitation world, with a relevant change in elderly proportion. In USA the mean age increased from 60.6 to 63.4 years, and the proportion of patients 75 years or older increased by 59% [4]. These changes prompted the physician to acquire a more specialized approach for the management of elderly complex patient to be rehabilitated. The Cardiac Rehabilitation 1996 AHCPR Guidelines identified smoking cessation, lipid management, weight control, blood pressure control, improved exercise tolerance, symptom control, return to work and psychological well-being/stress management as outcome to be reached by rehabilitation program [5].These outcomes are still to be the goal to achieve in an adult patient but are far from the real needs of the elderly, especially the oldest-old where disability is the main problem to manage [6]. Care of elderly patients in rehabilitation starts from the assessment of active problems at admission, continues through the phase of clinical stabilization and prevention of adverse clinical events and then continues in the recovery of frailty and disability through rehabilitation recovery paths, guided by careful clinical and

functional assessment based on comprehensive geriatric assessment (CGA) [7]. CGA is a tool capable of identifying the multiple dimensions of the older person and to evaluate the diseases (co-morbidity) and the function (cardiovascular, physical and cognitive) and any deficit (nutritional, disability and frailty), considering also the social support [8]. It identifies new concepts related to the elderly patient: the poly-factorial deficiency, the relative recovery and therefore the complexity. The concept of clinical complexity in the past was identified with the severity or difficulty of the clinical case based on a totally subjective value. To take this clinical judgment has an objective value we can refer to the diagram "certainty-consent", created by Stacey for the analysis of complex systems [9] and applied by Zimmerman et al. [10], and by Goldberger [11] in clinical models. The Stacey diagram and Zimmerman defines "simple" the system towards which there is the maximum of knowledge together with the maximum of consent by the operators; opposite the "chaos" characterizes the system in which the minimum of knowledge is accompanied by the minimum consensus; the "complex systems" are distributed in the area between simplicity and chaos. By transferring these concepts to clinical medicine, we can agree that the knowledge that we derive from the "Evidence Based Medicine" (EBM) serve to broaden the scope of "the simple medicine" and the "complexity" is identified with clinical medicine and chronic disability, characterized by the simultaneous presence of several clinical problems, for which the scientific knowledge is not yet complete and the solution of which is not only the clinical cure but the patient's functional recovery. The demographic revolution seen at the end of the last century in industrialized countries and in particular in Italy [12] resulted in a revolution in clinical medicine and rehabilitation, with a need of a more complex diagnostic evaluation approach [13] and a therapeutic-individual rehabilitation, able to maintain a continuing care facilities at different levels of health and social-health organization. This epidemiological scenario modified the hospital organization towards “Intensity of care”. In advanced age, in fact, is the high prevalence of multiple diseases, often in terminal stage, [14] with atypical clinical presentation [15] and therefore the diagnostic-evaluative and therapeutic approach to these patients should be driven by a CGA and in turn by a more complex system of clinical management. Several studies have shown that the CGA limits the incidence and severity of outcomes such as disability and mortality in elderly patients [16].

It should also be emphasized that the co-morbidity produce very complex situations. In the elderly cardiac patient is frequent the simultaneous detection of extra-cardiac co-morbidities and multiple cardio-vascular diseases (cardiovascular co-morbidity) [17]. The clinicians have to assess the role of “active co-morbidity” as clinically relevant and capable of compromising the functional state. The clinical association co-morbidity disability-is explained by the progressive loss of the anatomical and functional reserve of various organs and systems (vulnerability), characterizing the physiology of the different stages of geriatric age. Faced with these various biological conditions it is clear that the result on the functional state is different when the same disease affects adults or elderly and express different frames of disability as it increases the degree of vulnerability, reducing the anatomical and functional reserve [18] Furthermore, a complex situation can become simple when is managed in an organized system, capable of absorbing the different aspects of a complicated condition. Hence, it becomes essential to avoid the "chaos" of the system improving the facilities which in recent years have grown their "complexity" of care, such as intensive rehabilitation, they can adapt their systems to more complex standards and suited to the frail elderly population. Then, we can agree that the medicine of complexity is identified with the geriatric medicine: from a clinical point of view, in fact, the geriatric patient is characterized by a 'very advanced age, the age-related reduced functional reserve (vulnerability), from multiple risk factors, chronic comorbidity, disability, poly-pharmacy with a reduced compliance, and often with a critical socio-economic and environmental conditions. These conditions all together define the "frail status" of the geriatric patient [7]. This concept only recently identified, outlines a particular risk condition, i.e., by a reduction in capacity to perform basic activities of daily living, from a high co-morbidity and loss of functional reserve of organs and systems. Frailty is also considered as a result of changes in the neuromuscular system, the endocrine and immune systems. The criteria for identifying vulnerable people are not universally accepted. Numerous authors define frailty as the sum of a number of biological and clinical markers, and also, can be seen in a dynamic position between a healthy condition and a condition of extreme clinical severity status. Frailty further destabilizes clinic status and is necessary to prevent and treat not only in an "acute" setting but also in post-acute rehabilitation and home-care.

Several studies have demonstrated the efficacy of CR in the elderly since 1993 by Ades et al. [19], where in elderly patients with a baseline VO_2 max of 15.9 ml/kg/min in respect to younger patients (< 70 years old) with a VO_2 max of 21.5 ml/kg/min there was a greater improvement after CR in older patients versus younger. Similarly, Lavies et al. [20], demonstrated a greater improvement in exercise tolerance, quality of life and physical functioning in elderly, respectively (39% vs. 31%, 20% vs. 14% and 27% vs. 20%). More recent studies demonstrated in very old patients (> 75 years old) an increase of indexes of physical performance from baseline to discharge (VO_2 peak, 10.9%; 6MWT, 11.0%; peak torque, 11.5%). Baseline performance was independently associated with changes in all three indexes, with higher baseline values predicting less improvement confirmed that an exercise-based CR program is associated with improvement in all domains of physical performance even in older adults after an acute coronary event or cardiac surgical intervention, particularly in those with poorer baseline performance [21].

Rehabilitation Project and the Functional Recovery Program

The possibility of functional recovery is established through a preliminary evaluation by the rehabilitation team (RT). RT establishing the possible benefits and the time required for this to happen. Rehabilitation should takes place in the hospital soon after a heart attack, heart surgery, or other major heart problem (Phase 1). After the disease stabilization, at a stage where the clinical instability of the acute phase make possible the patient's participation to rehabilitation program it will start the (phase 2). The cardiac rehabilitation program could continue at an outpatient facility. Phase two of cardiac rehabilitation usually lasts from 3-6 weeks and involves continued monitoring of cardiac responses to exercise and activity. This opportunity is in this epidemiological scenario even less frequent due to the severe stage of the disease in the elderly patient and rehabilitation is preferred in specialized setting as inpatients. The assessment will also serve to identify the most suitable rehabilitation setting for the elderly (hospital, ambulatory or at home), having important studies demonstrated efficacy in post-infarction of home rehabilitation for low-risk patients [22] and in 75 year older patients

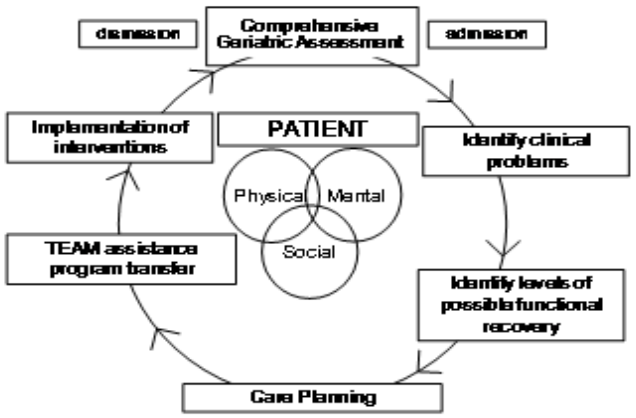

Figure 1: Comprehensive geriatric assessment – From the assessment to interventions.

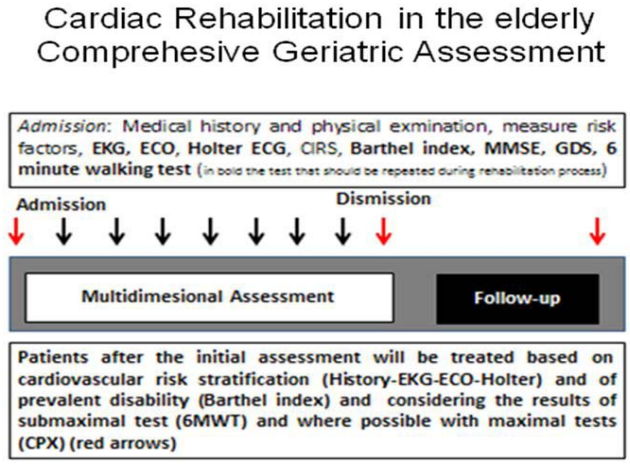

Figure 2: Cardiac Rehabilitation in the elderly Comprehesive Geriatric Assessment.

with a moderate frailty level [23,24] (Intensive Outpatient Therapy – Phase 3 – Independent ongoing conditioning – Phase 4).

The clinical and functional examinational lows quantifying the deficit, active and passive co-morbidity and guides the RT on the rehabilitation needs, diagnostic, therapeutic and patient management. Therefore, screening assessment at the entrance is the first step for the elaboration of a Rehabilitation Project and the functional recovery program. Initial evaluation also allows to evaluate the social and environmental factors, family conditions and therefore social support, housing conditions for the structural home changes for protected discharge at home and the availability of medical support.

Comprehensive Geriatric Assessment - CGA

The comprehensive geriatric assessment (CGA) is a key tool in the approach to the elderly patient. The CGA allows to analyze the various domains of the patient (physical, cognitive and social) at admission, during rehabilitation and at discharge. The CGA identify and prioritize clinical problems, identify the functional recovery objectives, planning care interventions, transfer the assistance program to the RT and verify the implementation of the interventions during the rehabilitation process (Figure 1). The functional evaluation in the elderly will be oriented mainly to measure degree of residual skills after acute event. Some authors have suggested that rehabilitation programs vary according to the meters walked in 6-minute walking test, which is a simple task that is predictive on long term mortality able to stratify the rehabilitation strategies [25,26]. The proposed algorithm identifies specific functional recovery routes based on functional residual capacity. Other models are centered on levels of frailty, built on the Frailty Staging System which identifies three classes and therefore different needs of functional rehabilitation [8]. The CGA uses tools of different grading: the most commonly used in rehabilitative environment are the Activity of Daily Living (ADL) [27], Barthel Index [28],Cumulative Index Rating Scale (CIRS) [29], Geriatric Depression Scale (GDS) [30], Mini-Mental State Examination (MMSE) [31], and functional assessment (6-minute walking test) [32], more oriented to the evaluation of cardiac patients, while the Tinetti [33] or the Short Physical Performance Battery (SPPB) [34] are tests used to evaluate balance and gait and physical functioning (Figure 2).

The evaluation of these functions is of great importance especially in the very old. In this regard, Lavies et al. [20], showed that the cardiovascular rehabilitative intervention leads to an improvement of the health status in general, the quality of life and a decrease in perceived pain. Furthermore, hostility, depression and anxiety are reduced to a greater extent in the very-old than in adults after CR [23,24].

Specific Protocols for Elderly Patients

To set the subdivision criteria of elderly subjects, in order to identify the best targets to be pursued with rehabilitation, we can refer, in a schematic way, to the cognitive and motor functions that are respectively expressed in the ability to perform, despite the presence of cognitive impairment, a functional recovery path, and preserved autonomy in performing IADL and ADL. At the moment, however, no known studies using the CGA oriented to rehabilitation have demonstrated the effectiveness of particular rehabilitation protocols. The questions that need answering are oriented to understanding if this population with conditions such as cognitive impairment, disability and frailty get a clinical and functional improvement with protocols designed to these special populations.

Physical rehabilitation, implemented in accordance with the risk assessment criteria related to the exercise and adapted to the different disease patterns, is an integral part of management of patient with cardiovascular disease. For rehabilitation purposes we have to make a distinction in the context of this population considering the burden of disability. As already mentioned, the patient with disability tends to coincide with the complex patient, embracing a wide spectrum of cardiovascular conditions and possibly extra-cardiac co-morbidity associated with the underlying cardiac disease, characterized by varying degrees of impairment of functional capacity. This impairment arises from a disability which, through a limitation of usual and, therefore, a restriction of the individual's participation in social life, determines different degrees of disability.

The rehabilitative intervention may be configured in patients less compromises in a physical training program, while the more functionally limited patients may be subjected to physical activity that, as controlled and programmed, cannot constitute a classical exercise program of effective workout. In any case, the patient's physical cardiovascular rehabilitation configures an operational framework "TEAM" involving in various reasons many actors

Table 1: Individualized protocols of training based on disability status.

Severe chronic Disability	Temporary severe Disability	Mild / moderate Disability	Without disability
Mobilization sessions active / passive	Mobilization sessions active / passive	Training sessions of variable load exercise with Assistive Movement Training Apparatus	Sessions of variable load exercise bike and treadmill as effective workout stimulus increasing intensity and sessions
Diaphragmatic respiratory gymnastics	Diaphragmatic respiratory gymnastics	Diaphragmatic respiratory gymnastics	Diaphragmatic respiratory gymnastics
Posture changes	Posture changes	Sessions of breathing exercises and calisthenics at a reduced energy expenditure, low, medium or high	Sessions of breathing exercises and calisthenics at a reduced energy expenditure, low, medium or high
Re-education sessions in motor impairment	Re-education sessions in motor impairment	Sessions of strengthening of individual muscle groups	Sessions of strengthening of individual muscle groups
Sessions of bronchial unblocking	Sessions of bronchial unblocking		
Sessions of calisthenics exercises	Sessions of calisthenics exercises		
Sessions with a muscle stimulation	Sessions with a muscle stimulation		
Muscular strengthening sessions	Muscolar strengthening sessions		
	Training sessions gait and walk.		

Table 2: Objectives of the rehabilitation based on disability status.

Severe chronic Disability	Temporary severe Disability	Mild / moderate Disability	Without disability
Improve the patient's ability to perform ADL	Improve the patient's ability to perform ADL	Improve the patient's ability to carry out the usual ADL	Increase the patient's functional capacity through traditional cardiovascular training and by means of resistance and / or strength training sessions
Reduce the level of supervision in ADL	Increase the patient's functional capacity	Increase the patient's functional capacity through training of the resistance and / or strength	Determining a training load applied at home once the patient has been discharged
Minimize the deconditioning due to loss of muscle tone	Reduce the level of supervision	If possible, determine a training load applied at home once the patient has been discharged	
Reduce adverse events	minimize the deconditioning due to loss of muscle tone;		
	Resolution of the bedridden and for the rehabilitation continued intervention as physical training.		

Legend: ADL=Activity of Daily Living.

Table 3: Outcome of the rehabilitation based on disability status.

Severe chronic Disability	Temporary severe Disability	Mild / moderate Disability	Without disability
Increase in the score of disability scales administered at the beginning of the rehabilitation process.	Increase in the score of disability scales administered at the beginning of the rehabilitation process.	Increase in the score of disability scales administered at the beginning of the rehabilitation process.	The increase of 6-minute walking test distance.
	If possible, the formal documentation of the termination of the setting bed using walking-6-minute test.	If possible, increasing the distance of 6MWT;	The increase of work capacity assessed by ET or CPX.
		If possible, increase the cardiovascular capacity assessed by ET or CPX.	

Legend: 6MWT=Six minute walking test. ET= Ergometric Test, CPX = Cardio-pulmonary exercise.

(doctor, nurse, physiotherapist, psychologist. etc.), the rehabilitation process of these patients will be strictly individualized in relation to their functional impairment / disability at admission and the usual functional capacity. The proposed following protocols do not follow the traditional approach of rehabilitation nosology in cardiology (i.e. different protocols for different events or acute or chronic diseases), but rather propose a transversal criterion for various conditions, based on different levels of disability of patients.

The Patient with Severe Chronic Disability

The patient with severe chronic disability is defined as a patient with at least 3 ADL lost [35] even present before the acute event. Patients in this category have to be defined as chronic disable. This category includes complex patients chronically bedridden for cardiac causes (refractory heart failure) or non cardiac causes (neurological complications with severely disabling outcomes, severe cognitive impairment, severe orthopedic limitations, etc.). The approach to severe chronic disability patient starts from the assessment and management of clinical stability and prevention of adverse events. In fact, soon after the acute phase of various clinical pictures (i.e., Myocardial infarction, unstable angina, pulmonary edema, stroke, etc.) it should be consider at least a passive mobilization of the patient for the prevention of thromboembolic event due to be dridden status, passing then, if possible, a physical activity program based on the procedures showed in (Table 1). The load physiotherapy related to the management of these patients is definable high. The objectives and outcomes of the rehabilitation for the patient with severe chronic disability are showed in (Table 2,3).

Temporary Severe Disabled

This category includes complex patients with 3 or more ADL lost due to the acute event, but free of disability before the acute event, temporarily bedridden for cardiac causes (heart failure instabilization, complex ventricular arrhythmias, acute ischemia, etc.) or non-cardiac causes (neurological complications, severe bedsores, poor evolution of surgical wounds, significant pulmonary

Table 4: The training intensity in different cardiovascular conditions.

Conditions	Light to Moderate	Moderate to high	High to severe	Severe to extreme
Chronic CAD (no residual ischemia)	√	√	√	√
Stable Angina	√[a]	√[a]	√[a]	
PCI	√	√	√	
Pacemaker	√	√		
ICD	√	√		
Chronic AF	√[b]	√[b]		
CABG	√	√	√	
Valve repair/replacement	√	√		
CHF	√	√	√	
LVAD	√			
Heart Transplantation	√[c]	√[c]	√[c]	

The grey areas identify intensity domains for which no scientific evidence is available in a specific population; CAD: coronaryartery disease; PCI: percutaneous coronary intervention; ICD: implantable cardio verter defibrillator; AF: atrial fibrillation; CABG: coronary artery by-pass grafting; CHF: chronic heart failure; LVAD: left ventricular assist device; a) Heart rate and/or work rate must in any case be lower than those corresponding to the ischemic threshold; b) Heart rate may not be usable due to highly variable chronotropic response; c) Heart rate may not be usable due to denervation-related blunted chronotropic response

complications with possible need for ventilatory support, febrile systemic infections, need of nutritional support, acute renal failure, delirium, severe pleural and / or pericardial effusion, severe anemia, etc.) considered for improvement and / or resolution. The level of disability of these patients will initially be quantified through Barthel Index (BI). In addition, it will be appropriate to quantify the level of habitual physical activity and comorbidities. The approach to the severe temporary disabled patient is based on the assessment and management of clinical stability. Also in these patients it should be consider at least a passive mobilization of the patient for the prevention of thromboembolic events, passing then (or immediately if the cause of the bedridden was not clinical instability) to a physical activity program based on the procedures showed in (Table 1).The load physiotherapy related to the management of these patients is definable moderate / high. The objectives and outcomes of the rehabilitation of the patient severe temporary disability complex are showed in (Table 2,3).

The Disabled Patient Mild / Moderate

It is defined mild / moderate disabled a patient with less than 3 ADL lost. This means that these patients may be functionally limited and sometimes even to a significant extent, but still lower than that of patient's severe disabilities. In this category are common patients in waiting list for heart transplantation during hemodynamic compensation, and possibly those recently transplanted patients with large pleural effusion and / or pericardial effusion and with significant anemia and patients with LVAD implantation where the limitation in ADL are also due to the ability to use the mechanical support. Depending on the clinical condition, the functional evaluation of complex mild / moderate disabilities patients can take advantage of the following tools:Barthel Index (ADL)

1. Walking-6-minute test (WT)
2. Conventional exercise testing (ET) or cardiopulmonary exercise testing(CPX)

The exercise program will be based on the procedures showed in (Table 1), variously associated with each other. The load physiotherapy related to the management of these patients is definable low / moderate. The objectives and outcomes of the rehabilitation of the patient mild / moderate disabilities are showed in (Table 2,3).

Table 5: ACSM classification of exercise relative intensity.

	%HRR or VO2R	%peak VO2	%peak HR	RPE Borg scale
Very light	<20	<25	<35	<10
Light	20–39	25–44	35–54	10–11
Moderate	40–59	45–59	55–69	12–13
Heavy	60–84	60–84	70–89	14–16
Very heavy	85	85	90	17–19
Maximal	100	100	100	20

Modified from Tipton et al. [37], ACSM: American College of Sports Medicine; HRR: Heart Rate Reserve; VO_2R: VO_2 Reserve; HR: Heart Rate; RPE: Rating of Perceived Exertion.

The Patient Not Disabled

It defines a patient without disability in ADL. This means that these patients are not limited in the basic activities of their daily lives. They will still be functionally limited to higher intensity activities depending on the severity of their underlying disease and / or comorbidities and their level of muscle conditioning (sedentary / active life). Depending on the clinical condition, the functional evaluation of non-disabled patients can take advantage of the following tools:

1. 6-minute walking test
2. Conventional CPX

The exercise program will be based on the procedures showed in (Table 1), variously associated with each other. The load physiotherapy related to the management of these patients is definable low / moderate. The objectives and outcomes of the patient's rehabilitation without a disability are showed in (Table 2,3).

The exercise intensity in elderly patients without disability depends by several factors (clinical instability, functional capacity, habitude to physical exercise). Sessions of variable load exercise with bike and treadmill with progressive increasing intensity and number of sessions are organized on the basis of the heart disease. (Table 4) The combination of these procedures in terms of duration, frequency and intensity will be individualized based on the patient's clinical condition. In any case, at least two daily sessions of the same procedure or two procedures seem applicable in the majority of patients. The progression of the load of physical activity criteria

privileges first an increase of duration of individual sessions, and then the frequency and finally intensity [36].

Heart rate (HR) is widely used for exercise intensity assessment and prescription on the basis that a linear relationship between HR and both VO_2 and Work Rate increase during incremental exercise. Thus, after having measured peak HR, (6-minute walking test or exercise test) the intensity of effort chosen as the training stimulus is indirectly determined by means of published regression equations or tables (Table 5) [37] as the percentage of the peak HR value corresponding to a given percentage of peak VO_2. On this basis, a 'target HR range' is usually proposed in normal subjects ranging between 70 and 85% peak HR [38]. In cardiac patients, available guidelines suggest training intensities equal to 40–80% peak VO_2, [37-39] that is, roughly ranging from 50 to 85% peak HR.

Conclusion

The rehabilitation process in the elderly should be implemented in accordance with the risk assessment criteria related to the exercise and adapted to the different disease patterns and disabilities. The patient's disability tends to coincide with a state of complexity, embracing a wide spectrum of cardiovascular and non-cardiovascular conditions associated with the underlying cardiac disease, characterized by varying degrees of impairment in functional capacity. This impairment arises from a disability which, through a limitation of usual and, therefore, a restriction of the individual's participation in his social life, determines different degrees of frailty. Therefore, the rehabilitative intervention may be driven by multidimensional assessment, configured in patients less compromises in a classical physical training program, while the more limited functionally patients may be subjected to physical activity that even if do not constitute an effective workout stimulus is still effective in the disability prevention. In any case, the cardiac rehabilitation configure an operational team framework involving various reasons many professions depending on the degree of disability and the different needs of the patient. The rehabilitation process of these patients will be strictly individualized in relation to their functional impairment / disability at admission and the usual functional capacity. The proposed protocols do not follow the traditional approach of rehabilitation in cardiology (i.e. different protocols for different events or acute or chronic diseases), but rather propose a transversal criterion for various clinical scenarios, based on different levels of patients' disability.

Dedication

This work is dedicated to the memory of PantaleoGiannuzzi, who died on August 20, 2016. Past-president of European Society of Cardiovascular Prevention and Rehabilitation, and Editor in Chief of European Journal of Cardiovascular prevention and rehabilitation. His daily commitment to the cardiac rehabilitation has led the development of this culture in Italy and Europe, with great attention to the most vulnerable patients such as the complex elderly.

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