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Exercise training effects on elderly and middle-age patients with chronic heart failure after acute decompensation: A randomized, controlled trial

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ABSTRACT

Background: The aim of this study was to evaluate the effect of exercise training on cardiac function in heart failure (HF) patients recently suffering from acute decompensation. Radionuclide ambulatory ventricular function monitoring (VEST) was used to detect variations in cardiac hemodynamics during training period.
Methods: This was a monocentric, randomized, controlled trial. We enrolled 72 HF patients [left ventricle ejection fraction (LVEF) <40%] within two weeks after acute cardiogenic pulmonary edema: 40 in the elderly group, 32 in the middle-aged group. Trained patients underwent a specific four-weeks exercise program (closed-chain resistive activities and abdominal exercises) which was supervised by a therapist in agreement with patients' characteristics. Catecholamines at rest, echocardiography, right-heart catheterization, and bicycle ergometer were performed. VEST was performed at the end of the 4 weeks-training in all patients in order to assess patients' cardiac hemodynamics [LVEF, cardiac output (CO), stroke volume].
Results: Exercise training significantly improved exercise duration, peak oxygen consumption, and ventilatory threshold both in elderly and middle-aged patients ($p < 0.0001$) after the 4-week controlled training. Despite age ($F = 35.086$, $p < 0.0001$; $F = 16.967$, $p < 0.0001$; $F = 42.574$, $p = 0.03$, respectively), training reliably influence previous cardiopulmonary parameters ($F = 29.402$, $F = 16.421$, $F = 26.80$, $p < 0.0001$, respectively). Norepinephrine and epinephrine were significantly reduced in both trained groups. Peak LVEF ($37.3 \pm 4.7\%$ vs $34 \pm 6.2\%$, $p = 0.002$), peak stroke volume ($43.3 \pm 3.9\%$ vs $37.5 \pm 4.3\%$, $p = 0.001$), and peak CO ($63.4 \pm 6.1\%$ vs $48.2 \pm 4.7\%$, $p < 0.0001$) increased in middle-aged patients after 4-week training.
Conclusions: Exercise training improves cardiac performance indexes and pulmonary function in both middle-aged and elderly HF patients early after an acute episode of cardiac decompensation.

1. Introduction

Congestive heart failure (HF), a strictly age-related condition [1], is the final stage in several heart diseases (ischemic heart disease; valvular alterations; cardiomyopathies; etc) and represents a dramatic challenge to national health financial and therapeutic policy [2].

Advanced HF can be detrimental to patients' survival, above all if combined to comorbidities and/or increased age [3,4]. Furthermore, the reduction in physical activity due to chronic illness, sedentary lifestyle, nutritional deficiencies, and aging itself promotes the progression of heart dysfunction. Inactivity, in turn, leads towards a continued decline in remaining functional capacity [5,6]. This vicious circle can be interrupted by discouraging sedentary lifestyle and promoting rehabilitation programs [7].

Exercise programs improve cardiac function and peripheral adaptation during exercise in healthy individuals [8]. Apart from adaptation in maximal cardiac output, heart contractility, and stroke volume, aerobic exercise training is also able to promote amelioration in the peripheral microvascular background by reducing resistance to flow, increasing the compliance of the arteries and endothelial function [8]. Data from

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HF patients seemed to confirm peripheral and cardiac adaptations as the main contributing factors in amelioration of cardiovascular status of these patients after specific exercise training [9,10]. The positive effect of training on patients suffering from chronic HF has been repeatedly documented [5–7,11], but the vast majority of these studies involved middle-aged patients (i.e. patients aged <65 years old [12]) suffering from chronic HF and in New York Heart Association (NYHA) functional class II and III [9,10,13]. Few data are available about how older chronic HF patients (i.e. patients aged more than or equal to 65 years old [12]) may benefit from an exercise training period [9,14].

Advancing age can be detrimental for heart performances due to modifications in structure and function of the cardiac muscle cells [13]. Nevertheless, exercise training provides modulation in biochemical pathways related to cardiac cells, which partially reverse the negative influence of age on heart performances [15]. Also, peripheral modifications can explain the amelioration observed in older individuals after training: such modifications seem to be more influent on body response to exercise training in elderly as compared to younger individuals who demonstrated the combination of central and peripheral adaptations [16]. Therefore, older individuals may show benefits from exercise training although the effects could not be promptly available as compared to middle-aged persons. Heart failure can even worsen the recovery of the heart from its functional and morphological declining, above all after an acute decompensation event.

The evaluation of the effects of exercise training in both middle aged and older patients performed early after an episode of acute decompensated HF is not well-represented in literature.

In this prospective, randomized study we evaluated the effect of exercise training on work capacity and cardiac function by means of radionuclide ambulatory ventricular function monitoring (VEST) in middle aged and old patients with HF recently recovering from acute cardiac decompensation. The availability of a radionuclide detector (VEST, Capintec, Inc., Ramsey, New Jersey) for monitoring left ventricular function allowed non-invasive evaluation of the cardiac response to daily activities [17,18]. The theoretical basis for using such device is related to its ability in firstly monitoring cardiac hemodynamic parameters such as left ventricular ejection fraction (LVEF), cardiac output, end systolic and diastolic volumes during exercise test; secondly to provide parallel acquisition of electrocardiographic variations during exercise. The purpose is to provide a full evaluation of heart function during exercise test and to detect early and subtle alterations in cardiac hemodynamics during exercise, as such events may sometimes be misunderstood and/or unrevealed by ECG stress test [17–19]. The higher reproducibility coefficients demonstrated by this technique in previous studies [17], offers physicians the possibility to reliable use it in daily clinical rehabilitation practice in order to obtain full information about the performances of patients' heart.

We purposed to assess whether physical training could improve exercise capacity in older and middle-age patients after acute decompensation and, in the event of a confirmatory answer, to evaluate which type of adaptations (cardiovascular or non-cardiovascular, central or peripheral) underlies the response.

2. Methods

2.1. Patients

We enrolled consecutive patients that have been discharged from emergency care unit within two weeks after acute cardiogenic pulmonary edema (respiratory rate > 30 breaths per minute, bilateral lung rales, bilateral alveolar-interstitial imbibitions on chest X-ray, arterial oxygen <80 mmHg at room air).

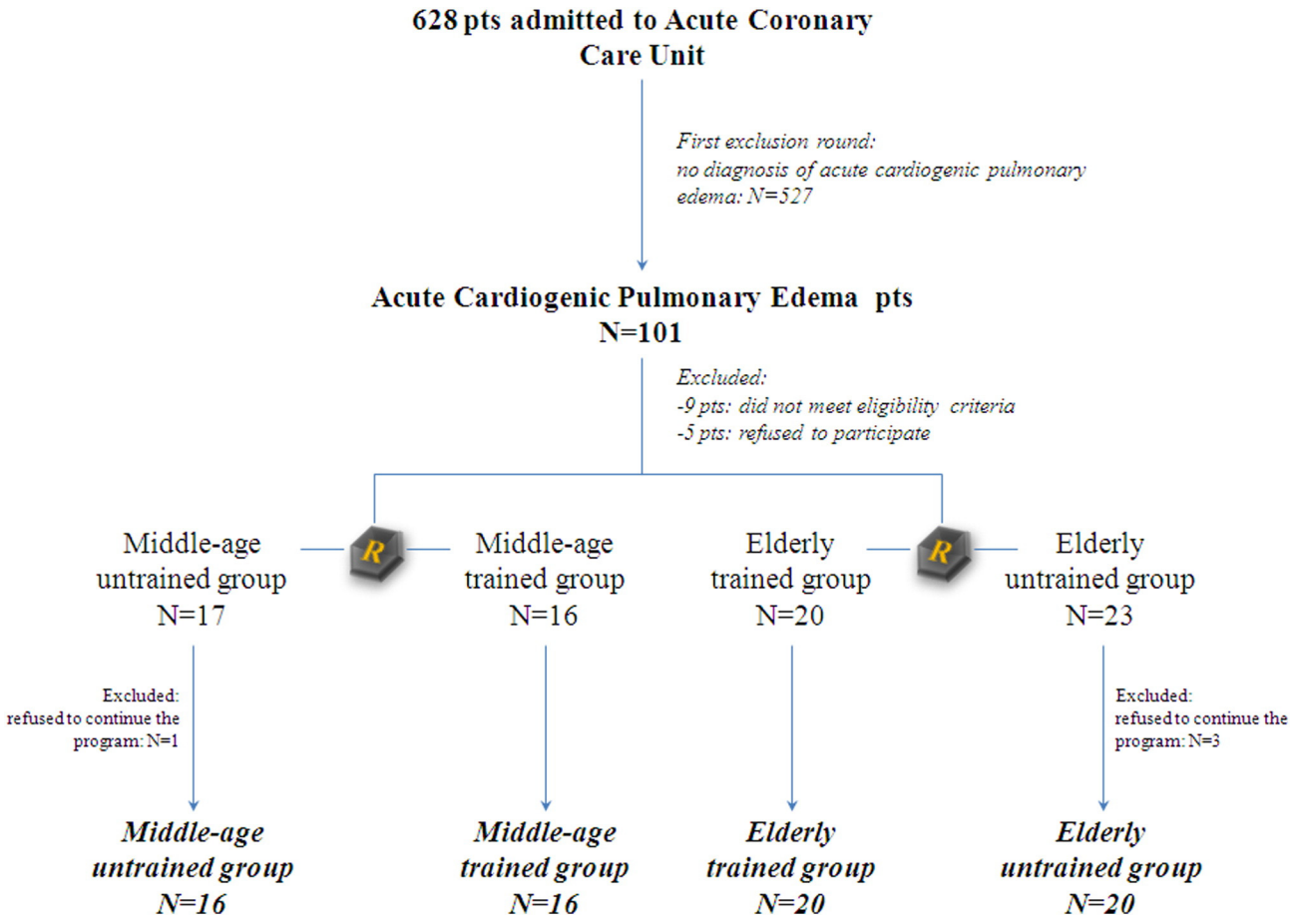

Fig. 1. Flow chart of the study.