Cardiovascular disease patients and predictors of length of stay of residential of cardiac rehabilitation. A specific rehabilitation is mandatory in very old patients?

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Abstract

As more adults are living into old age, they are predisposed to cardiovascular disease (CVD) and the demand for cardiac rehabilitation is increasing. We aimed to verify predictors of length of stay (LOS) in young (Y) *vs* older (O) *vs* very old (VO) CVD patients, admitted to residential cardiac rehabilitation. Patients' demographic and clinical characteristics at admission, as well as Barthel index (BI), Cumulative Illness Rating Scale (CIRS), comorbidity severity/complexity, NYHA classification, left ventricular ejection fraction (LVEF), physical activity level were compared in Y (≤65 years) *vs* O (between >65 and <76 years) *vs* VO patients (with an age of ≥76 years) against LOS. In 5,070 consecutively CVD patients were included; they were 1392 Y (38%) 1944 O (35%) 1334 VO patients (27%) and LOS duration was 16±7, 19±9 and 22±10 days, respectively (p<0.0001). In Y, LOS was linked to BI (p=0.000) and to LVEF (p=0.000) at multivariable analysis with area under ROC curve of 0.82, whereas in O, LOS was associated to gender (p=0.013) CIRS severity (p=0.000), BI (p=0.000), LVEF (p=0.000), and in those VO to gender (p=0.004), BI (p=0.000) and medical infusion (p=0.000) at multivariable with ROC curve of 0.83 and 0.74, respectively. In very old patients, a prolonged LOS is related to extra-cardiac conditions. Therefore, we promote a specific cardiac rehabilitation for these patients.

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Abbreviation list
length of stay (LOS)
cardiovascular disease (CVD)
Young patients, ≤65 years (Y).
Old patients, between 66 and 75 years (O).
Very old patients, ≥76 years (VO).
Residential Cardiac Rehabilitation (R-CR).
Heart transplantation (HxT).
Left ventricular assistance device (LVAD).
Sub-intensive care unit (SICU)
Barthel Index (BI).
Cumulative Illness Rating Scale (CIRS).
Left Ventricular Ejection Fraction (LVEF).
Physical activity (PA)
New York Association functional class (NHYA).
Sinus rhythm (SR).
Atrial fibrillation (AF).
Supervised monitoring with ECG -telemetry (SpM).
Electrocardiogram (ECG).
Particular medications prescribed (PMP).
Complications after cardiac surgery or after the acute episode (Cs).
Particular medications prescribed at admission (PMP).
Respiratory medications (PMP-R).
Antibiotic medications (PMP-A).
Infused therapy medications (PMP-IT).

Introduction

By 2060, people 65 years and over will constitute 28% of the population in Europe. The population growth means an increasing demand for hospital care [1]. The average length of stay (LOS) in hospitals is an efficient indicator: a shorter stay will decrease the cost per discharge and shift care from inpatient to less expensive post-acute settings, while longer stays can be representative of poor-value care. Reducing LOS is a way of containing the growing demand for beds [2]. Clinical research has focused on ways to reduce LOS in acute setting [3-9], whereas few have analyzed the role of reducing LOS in post-acute settings [10]. Post-acute care looks like cardiac rehabilitation [11]. We speculate that LOS should be related to age in cardiovascular disease (CVD) patients: elderly patients are more prone to have concomitant diseases or they could have complications during the acute event. Thus, we aimed to verify clinical predictors determined before entry or at admission (within 48 h) of LOS in young (Y) old (O) and very old (VO) patients, admitted to residential cardiac rehabilitation (R-CR). A prolonged LOS is defined as more than 30 days [12], including weekends.

Methods

Study population

Data on consecutive CVD patients, admitted to R-CR (individually adapted: physiotherapy was provided in the gym room: six days per week. Medical supervision was delivered two times a week while nurse management was offered every day. Risk-education sessions were dispensed by psychologists, every week, twice, and, similarly, psychological support sessions for patients who were most vulnerable) between January 1st, 2008 and May 31st, 2013, were screened and collected in a prospective database in the Hospital Information System. We excluded patients i) who died during R-CR; ii) who were transferred from R-CR back to acute care or to a hospice (to continue assistance and surveillance); iii) who signed themselves out against medical advice; iv) who were recipients of heart transplantation (HxT) and left ventricular assistance devices (LVAD), since LOS was maintained until the last endo myocardial biopsy during R-CR was performed and LVAD functioning for patients and families, 24-hemergency, and device manufacturer were provided, and/or when international normalized ratio (INR) was in therapeutic range for the device, at least two measurements, even if recipients were asymptomatic and were fully restored; and v) CVD patients admitted to R-CR (within 60 days).

Predictors documents at admission

We gathered information, at entry about demographic characteristics (sex and age), mode of admission (cardiac ward: NO/YES), CVD diagnosis, medications, functional status, and medical history (risk factors, i.e., smoking, familiarity for coronary artery disease and for diabetes mellitus, arterial hypertension, high serum lipid concentration, renal failure: YES/NO). We employed the Barthel Index (BI) to measure patients' level of autonomy [13] and, we classified BI scores as follows: ≤60 = dependent/severely disabled, >60≤85 = moderately disabled, ≥85≤95= mildly disabled, and 95–100=independent [14]. Cumulative Illness Rating Scale (CIRS) was used to assess the burden of comorbidity, either in terms of severity or complexity [15]. We recorded when physical activity (PA) was commenced: whether soon (≤48 h) or late (>48 h). New York Association (NYHA) functional class, who prescribed the R-CR (general practitioner: NO/YES), presence of sinus rhythm (SR) or atrial fibrillation (AF) at admission (SR: NO/YES), supervised monitoring throughout ECG-telemetry (SpM: NO/YES), complications (Cs) during the acute episode, before attending R-CR (Cs: NO/YES), and particular medications prescribed (PMP) i.e., respiratory therapy (PMP-R: NO/YES), oral or intravenous antibiotics for elevated body temperature or infective disease (PMP-A: NO/YES) or infusion medical therapy (intravenous) medicines for weakness, for clinical status stabilization and nutritional support; PMP-IT: NO/YES) were also recorded. Respiratory medical therapy includes oxygen therapy, corticosteroids and other respiratory medicines.

All patients underwent a 2D-echocardiography for left ventricular ejection fraction (LVEF) evaluation (Simpson's method) within 48 h of admission of R-CR.

Length of stay

Length of stay was defined as the number of days from admission to discharge: more than 30 days was defined as a prolonged LOS.

Statistical analysis

All calculations were performed using the STATA 10 system (StataCorp, College Station, TX, USA). Continuous data were summarized as mean ± SD. One-way ANOVA analysis was used for comparing quantitative variables between the different age groups, with Bonferroni post-hoc comparison in case of statistical significance. For qualitative variables, the χ^2 test with Yates' correction or Fisher's exact test, if necessary, was employed. The level of statistical significance was set at a two-tailed p-value <0.05. A logistic regression to estimate independent predictors of prolonged LOS, for each category of age was adopted. Sensitivity and specificity of the model in predicting prolonged LOS in R-RC were used to build a receiver-operating characteristic (ROC) curve and to compute the Area Under the Curve (AUC), as an indirect measure of the model's predictive power [16].

Results

Four hundred and eighty-four patients were excluded (HxT or LVAD recipients, n=211; irregular discharge, n=206; died during R-CR, n=15, and patients readmitted to R-CR, n=52). Figure 1 resembles flowchart. According to inclusion and exclusion criteria, 5.070 CVD patients were enrolled: total cohort was summarized in Table 1. In total cohort, mean LOS during R-CR was 19±9 days: prolonged LOS (≥30 days) was 9%. Mean age, LVEF, CIRS severity and complexity of the enrolled patients were 67±11 years, 53±12%, 1.53±0.28, 2.62±2.4, respectively, while males represented 67%. Mean BI score at entry was 82±18: 15% of patients were classified as independent, 40% showed mild disability, 27% moderate disability, and 18% severe disability. We divided 5.070 CVD patients in young [(Y) ≤65 years-1792 patients], in old [(O) between 66 and 75 years-1944 patients] and very old [(VO) ≥76 years-1334 patient]. Y, O and VO patients showed a prolonged LOS in 76, 181, and 211 patients (p<0001). We compared Y *vs* O *vs* VO patients for documentations at entry (Table 2). Moreover, we examined normal and prolonged LOS compared to age of CVD patients (Tables 3 to 5). At univariate logistic analysis for prolonged LOS prediction, BI (p=0.000)

LVEF (p=0.024) and acute or chronic AF at entry (p=0.014) were chosen, and multivariable analysis are showed in Table 6. Gender (p=0.041), CIRS severity (p=0.008), BI (p=0.000) LVEF (p=0.007) and AF (p=0.040) were picked at univariate logistic analysis in O ones whereas, at multivariable analysis, variables selected are shown in Table 6. In VO patients, gender (p=0.003), BI (p=0.000) LVEF (p=0.0391) and drug infusion (p=0.024) were elected at univariate analysis, while only three variables were independently selected at multivariable logistic analysis: gender, BI and medical infusion therapy (Table 6). Figure 2 shows the AUC values of the ROC curve of Y, O and VO CVD patients.

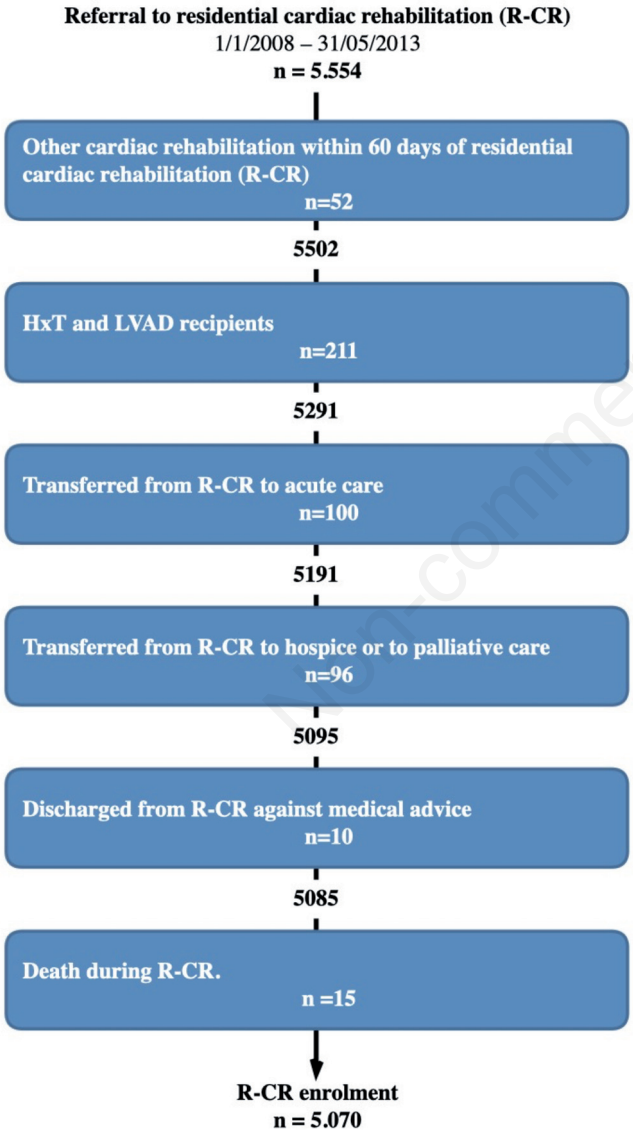

Figure 1. Flowchart presenting number of eligible cases remaining at each step as exclusion criteria are applied. R-CR, residential cardiac rehabilitation; HxT, heart transplantation; LVAD, left ventricular assistance device.

Discussion

Some findings deserve mention: i) prolonged LOS is linked to age in CVD patients admitted to R-CR; ii) clinical characteristics are different in young, old and very old patients; iii) prolonged LOS is common in very old patients compare to young and old ones; iv) in very old patients, cardiac disease seems not decisive. A prolonged LOS in very old patients is fairly common. CIRS severity values are greater in very old (1.63±0.28) compared to young (1.52±0.26; p<0.0001) and old patients (1.60±0.28, p=0.0057). Finally, in very old patients, neither CVD etiology nor LVEF were selected at mul-

Table 1. Total cohort of CVD patients admitted to R-CR. Data are expressed as mean value ± SD or number (%) of patients or in percentages.

	Total cohort
Patients	5070
Gender-make (%)	67
Age (years)	67±11
Length of stay (days) of R-CR	19±9
Percentage with prolonged LOS (%)	9
Barthel index	82±18
Normal: Y (%)	15
Mild disability: Y (%)	40
Moderate disability: Y (%)	27
Severe disability: Y (%)	18
LVEF (%) at admission	53±12
CIRS severity	1.53±0.28
CIRS complexity	2.62±2.4
NYHA classification	2.61±0.63
Patients with risk factors for CVD	
One, %	26
Two, %	30
Three, %	18
Four, %	5
Five, %	0.4
Etiology of CVD	
Arrhythmias, %	0.7
BPAC, %	49
Valvular CS, %	12
Combined CS, %	2
Chronic CAD, %	7
HF, %	4
Vascular S, %	5
Others, %	0.5
Medications	
Respiratory therapy: Y (%)	14
Infused therapy (for clinical and functional stabilization): Y (%)	2.8
Antibiotic therapy: Y (%)	4.1

CVD, cardiovascular disease; R-CR, residential cardiac rehabilitation; LOS, hospital length of stay; CIRS, cumulative illness rating scale; NYHA, New York Heart Association; LVEF, left ventricular ejection fraction; BPAC, coronary artery bypass grafting; CS, cardiac surgery; S, surgery; CAD, coronary artery disease; HF, heart failure; Y, yes.

tivariable analysis, putting forward that heart condition is not as crucial as in young and old ones. R-CR must be oriented to young and old individuals with CVD and structured, residential rehabilitation should provide to very old people with co-morbidities.

CVD remains the leading cause of death in Europe. Though cardiac rehabilitation (CR) represents a component in the continuum of care for CVD patients [17-18], and it is incredibly powerful tool [19-21], still some patients are less likely to access: women, those of low

Table 2. Differences of CVD patients according to age and documents (at entry). Significant values are in bold.

	Young *vs* old patients p-value	Young *vs* very old patients p-value	Old *vs* very old patients p-value
Gender	**<0.0001**	**<0.0001**	**<0.0001**
Etiology	**<0.0001**	**0.0001**	0.3628
NYHA classification	**<0.0001**	**<0.0001**	**<0.0001**
CIRS severity	**<0.0001**	**<0.0001**	**0.0057**
CIRS complexity	**<0.0001**	**<0.0001**	0.0936
Barthel index	**<0.0001**	**<0.0001**	**<0.0001**
LVEF	**0.0462**	**0.0187**	0.5836
Rhythm, at entry	**<0.0001**	**<0.0001**	0.0567
Admission at ward	**0.0452**	**<0.0001**	**0.0109**
Risk factor for CVD	**0.0011**	0.3421	**0.0416**
Co-morbidity	**<0.0001**	**<0.0001**	0.5676
Physical activity	**<0.0001**	**<0.0001**	0.1500
Respiratory therapy	**<0.0001**	**<0.0001**	0.2211
Antibiotic therapy	0.2234	**0.0239**	0.2464
Infusion medical therapy	0.0673	**<0.0001**	**0.0169**

CVD, cardiovascular disease; NYHA, New York Heart Association; CIRS, cumulative illness rating scale; LVEF, left ventricular ejection fraction.

Table 3. Cohort of young CVD patients according to LOS duration. Data are expressed as mean value SD or % of patients.

	Normal LOS	Prolonged LOS	p-value
Patients (n)	1716	76	
Age (years)	54±8	56±7	0.0752
Gender (male) (%)	69	50	<0.0001
Race (Caucasians) (%)	97	98	0.7336
NYHA	1.9±0.55	2.5±0.87	<0.0001
Barthel index	90±16	69±25	<0.0001
Independent; Y (%)	16	12	<0.0001
Mild disability; Y (%)	42	11	<0.0001
Moderate disability; Y (%)	26	22	
Severe disability; Y (%)	16	55	
LVEF	56±12	48±16	
CIRS severity	1.5±0.26	1.6±0.22	<0.0001
CIRS complexity	2.3±1.9	3.0±2.0	0.0054
Patients with risk factors for CVD; Y (%)	79	73	0.6841
Etiology of CVD: IHD; Y (%)	63	62	0.9101
Institutions prescription; Y (%)	92	93	0.9166
Admitted to ward; Y (%)	98	78	<0.0001
Sinus rhythm; Y (%)	80	52	<0.0001
Complicated acute episode: Y (%)	55	61	<0.0001
Physical activity: Y (%)	53	47	0.0048
Respiratory therapy; Y (%)	13	26	<0.0001
Infused therapy: Y (%)	4.5	27	<0.0001
Antibiotic therapy: Y (%)	2	15	<0.0001

CVD, cardiovascular disease; LOS, length of stay; NYHA, New York Heart Association; Y, yes; LVEF, left ventricular ejection fraction; CIRS, cumulative illness rating scale; IHD, ischemic heart disease.

Table 4. Cohort of old CVD patients according to LOS duration. Data are expressed as mean value ± SD or % of patients.

	Normal LOS	Prolonged LOS	p-value
Patients (n)	1763	181	
Age (years)	70±3	71±3	0.0622
Gender (male) (%)	69	50	<0.0001
Race (Caucasians) (%)	97	98	0.7336
NYHA	2.1±0.58	2.5±0.87	<0.0001
Barthel index	84±16	61±25	<0.0001
Independent; Y (%) Mild disability; Y (%) Moderate disability; Y (%) Severe disability; Y (%)	16 40 26 18	12 11 22 55	<0.0001
LVEF	53±12	49±15	<0.0001
CIRS severity	1.3±0.3	1.5±0.2	<0.0001
CIRS complexity	3.2±2.0	3.7±2.0	<0.0001
Patients with risk factors for CVD; Y (%)	80	86	0.3690
Etiology of CVD: IHD Y (%)	64	63	0.2815
Institutions prescription; Y (%).	94	95	0.1532
Admitted to ward; Y (%)	98	78	<0.0001
Sinus rhythm; Y (%)	95	48	<0.0001
Complicated acute episode: Y (%)	41	65	<0.0001
Physical activity soon after admission: Y (%)	53	48	0.1070
Respiratory therapy; Y (%)	14	31	<0.0001
Infused therapy: Y (%)	7.3	34	<0.0001
Antibiotic therapy: Y (%)	3	15	<0.0001

CVD, cardiovascular disease; LOS, length of stay; NYHA, New York Heart Association; Y, yes; LVEF, left ventricular ejection fraction; CIRS, cumulative illness rating scale; IHD, ischemic heart disease.

Table 5. Cohort of very old CVD patients according to LOS duration. Data are expressed as mean value ± SD or % of patients.

	Normal LOS	Prolonged LOS	p-value
Patients (n)	1223	211	
Age (years)	79±9	79±10	0.3205
Gender (male) (%)	56	45	0.0015
Race (Caucasians) (%)	93	110	0.7336
NYHA	2.5±0.8	2.8±0.8	<0.0001
Barthel index	76±19	54±22	<0.0001
Independent; Y (%) Mild disability; Y (%) Moderate disability; Y (%) Severe disability; Y (%)	8 22 25 35	2 8 20 70	<0.0001
LVEF	53±14	51±13	0.0116
CIRS severity	1.5±0.30	1.6±0.21	<0.0001
CIRS complexity	2.7±2.0	3.4±2.0	<0.0001
Patients with risk factors for CVD: Y (%)	86	81	0.2434
Etiology of CVD: IHD; Y (%)	64	63	0.2815
Institutions prescription: Y (%).	94	95	0.1532
Admitted to ward: Y (%)	99	96	<0.0001
Sinus rhythm: Y (%)	92	96	0.0167
Complicated acute episode: Y (%)	43	64	<0.0001
Physical activity soon after admission: Y (%)	53	47	0.0342
Respiratory therapy: Y (%)	13	30	<0.0001
Infused therapy: Y (%)	7	31	<0.0001
Antibiotic therapy: Y (%)	3	14	<0.0001

CVD, cardiovascular disease; LOS, length of stay; NYHA, New York Heart Association; Y, yes; LVEF, left ventricular ejection fraction; CIRS, cumulative illness rating scale; IHD, ischemic heart disease.

socioeconomic status, patients living in rural areas, ethnocultural minorities and very old adults. Very old patients are excluded due to severe concomitant diseases: cognitive impairment, renal failure and bronchopulmonary and metabolic infectious diseases are the main diseases encountered [22]. Despite appropriate treatment, very old CVD patients often suffer physical difficulties and, grounded on clinical conditions, cardio-geriatric physicians should intervene, as soon as possible with i) medico technical interventions; ii) appropriate nutrition; and iii) CR aimed at getting the patient back to physical activity as early as possible [22]. There are several types of CR program designs, including both inpatient and outpatient variations, providing opportunities to contend with complexities in very old CVD patients, including i) multimorbidity; ii) polypharmacy; iii) detrimental processes of care; iv) sarcopenia; and v) the challenge of education/decision making/and behavioral changes in the context of declining cognition.

Rehabilitative care requires patients to be stable, in order to actively participate in the intensive rehabilitation program: it starts from the assessment of active problems, and continues through the phase of clinical stabilization and prevention. The diagnosis of CVD requires an understanding of the interplay between patient heterogeneity, the activity of chronic and acute conditions, functional status, pharmacology, and social factors [23]. The comprehensive geriatric assessment (CGA) identifies and prioritizes clinical problems, functional recovery objectives and planning of care interventions. Various instruments are now accessible: activity of daily living [24], BI [13,14], CIRS [15], geriatric depression scale [25] mini-mental state examination [26], functional assessment (6-min walk test) [27], Tinetti [28] and short physical performance battery [29]. Complexity belongs to CR: older patient is a patient with reduced functional reserve, from chronic comorbidity, disability, polypharmacy and a reduced compliance [20]. Co-existing disease further adds complexity. This accumulation is the result of genetics, lifestyle choices, environmental factors, treatment of prior conditions and aging itself and culminates in a vastly heterogenic older population. Amongst Medicare beneficiaries with a diagnosis of CVD, the burden of multimorbidity is significant: in elderly patients with ischemic heart disease, heart failure, stroke and atrial fibrillation the most common concomitant conditions are arthritis, anemia and diabetes mellitus and rates range from 40-50% whereas other common chronic conditions include chronic kidney disease, cognitive impairment, chronic obstructive lung disease and depression [30]. Exercise programs are suggested: they should increase flexibility, muscular strength, and aerobic endurance. Given that physical activity is good in elderly patients, the question arises whether some kinds of physical activity are better than others. Exercise can be classified in five categories: resistance, aerobic (endurance), balance, flexibility, and functionally based. Technology application, for better exercise during CR, are well-known [31,32]: a survey of 200 patients discovered that a remote digital CR program would be acceptable to most cardiac patients, including the older population [33].

Table 6. Multivariable predictors of prolonged length of stay, according to age. Significant parameters are in bold.

	X_2	p-value	95% CI
Young patients			
Gender	0.39	=0.843	0.38-2.43
CIRS severity	6.99	=0.052	4.2-103.3
LVEF	**14.8**	**=0.000**	**0.92-0.97**
Barthel index	**23.9**	**=0.000**	**0.93-0.97**
Sinus rhythm: Y	1.29	=0.258	0.45-1.41
Ward admission: Y	0.54	=0.458	0.68-3.45
Infused therapy: Y	1.28	=0.164	0.79-4.71
Old patients			
Gender	**15.7**	**=0.013**	**0.36-0.86**
CIRS severity	**18.0**	**=0.000**	**1.36-31.3**
LVEF	**16.8**	**=0.000**	**0.95-0.98**
Barthel index	**80.1**	**=0.000**	**0.94-0.96**
Sinus rhythm: Y	1.29	=0.258	0.45-1.41
Ward admission: Y	0.05	=0.934	0.53-6.41
Infused therapy: Y	1.28	=0.164	0.79-4.71
Very old patients			
Gender	**10.8**	**=0.004**	**0.38-2.43**
CIRS severity	8.99	=0.002	4.2-103.3
LVEF	8.03	=0.056	0.92-0.97
Barthel index	**23.9**	**=0.000**	**0.93-0.97**
Sinus rhythm: Y	1.29	=0.258	0.45-1.41
Ward admission: Y	0.54	=0.458	0.68-3.45
Infused therapy: Y	**18.4**	**=0.001**	**0.29-0.99**

CI, interval of confidence; CIRS, cumulative illness rating scale; LVEF, left ventricular ejection fraction; Y, yes.

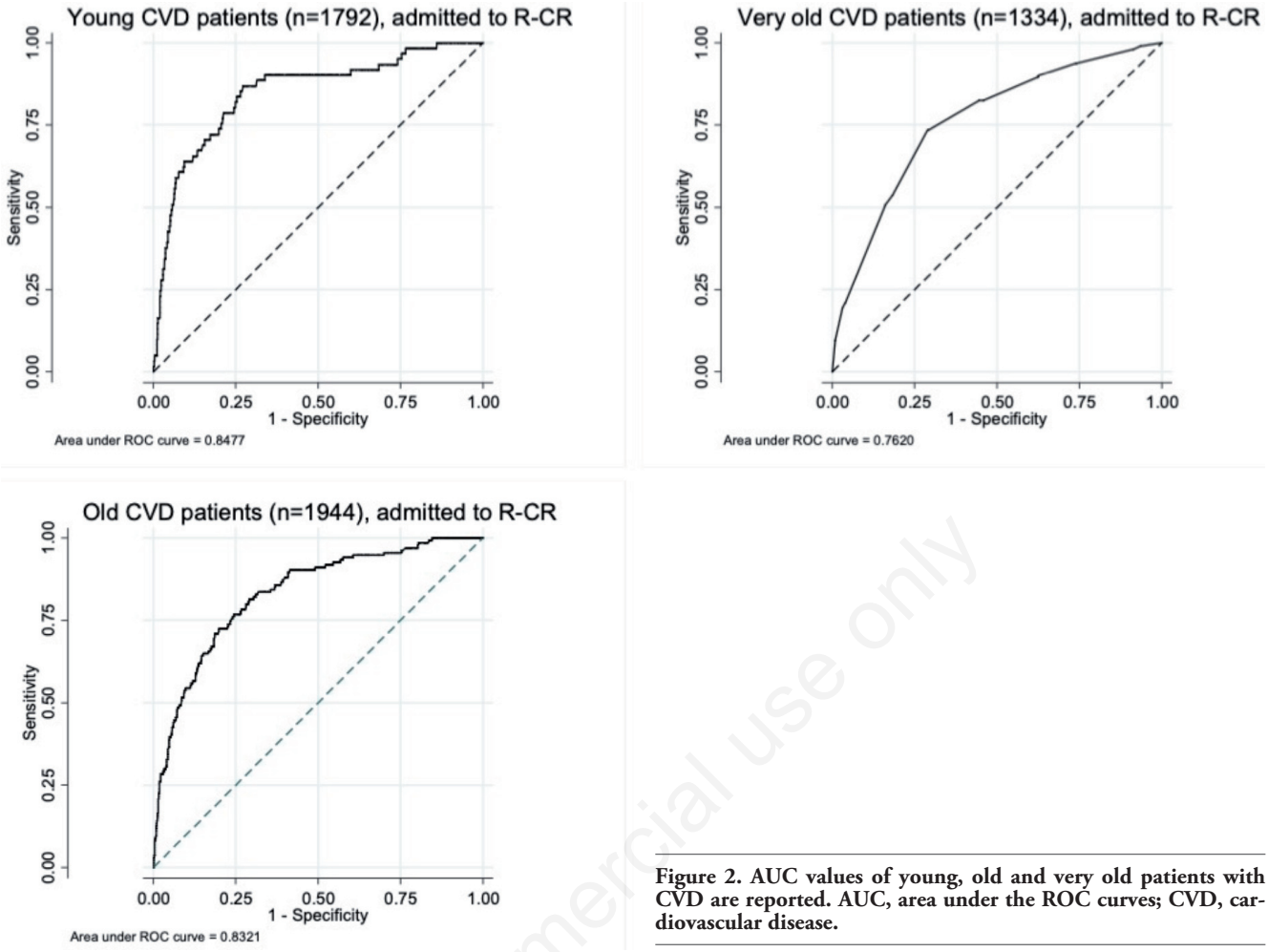

Figure 2. AUC values of young, old and very old patients with CVD are reported. AUC, area under the ROC curves; CVD, cardiovascular disease.

Limitations

This report has some limitations: i) total cohort is outdated: however, it represents CR population in Italy [34] and these results are used as a reference for other consequences that involved more recent CVD patients; ii) data analyzed come from a single center, therefore, caution is needed in generalizing them; iii) even though we analyzed a very large number of variables, describing hospital stay characteristics, a number of other factors were not accounted for; iv) a huge sample on CVD patients admitted to R-CR was afforded, but a control group is lacking: thus, a bias is possible; v) many CR programs do not receive full reimbursement. This fact may have an impact on LOS: when the patient is physically restored and risk-education is provided, he or she leaves the R-CR. Physicians, who are in charge of patients, assumed a clinical rather than an economic perspective.

Conclusions

Age correlates with LOS in CVD patients admitted to R-CR, and very old CVD patients have a prolonged LOS, but they are more likely to be affected by extra-cardiac conditions that prolong the LOS duration: thus, cardiac disease appears to be less decisive in very old CVD patients when compared to younger and older patients. Further research is needed to better quantify the impact of these variables on LOS in CVD patients admitted to R-CR in a multicenter trial, as well as to determine whether a new cardiac-geriatric rehabilitation program can be beneficial in elderly patients.

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