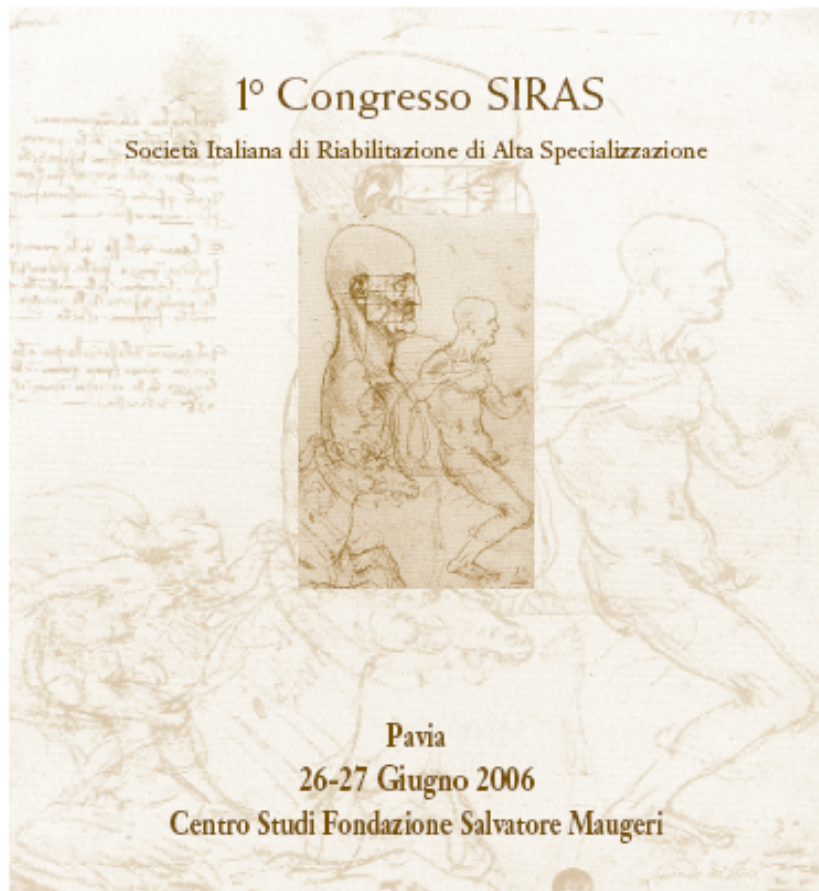




## Le Frontiere della Riabilitazione Multispecialistica



1° Congresso SIRAS

Società Italiana di Riabilitazione di Alta Specializzazione



Pavia

26-27 Giugno 2006

Centro Studi Fondazione Salvatore Maugeri

## **La valutazione del rischio delle procedure riabilitative nei pazienti con grave disabilità**

**Andrea Passantino  
Divisione di Cardiologia  
Fondazione S. Maugeri, IRCCS  
Cassano delle Murge (Bari)**

# Il rischio del training fisico

- Fisiopatologia
- Epidemiologia
- Stratificazione



## Esercizio



[K<sup>+</sup>]



pH



[catecolamine]

## Recupero



[K<sup>+</sup>]



pH

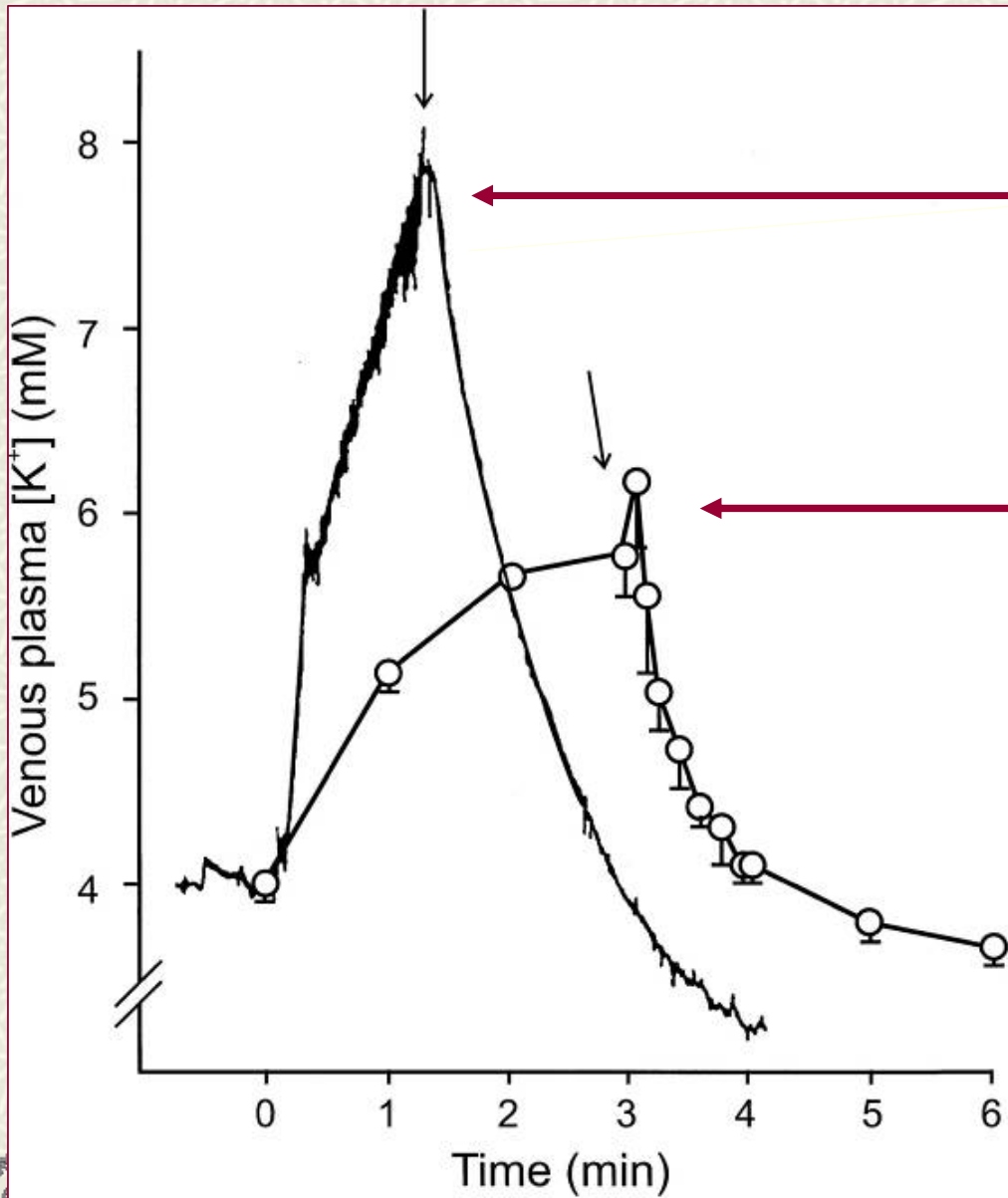


[catecolamine]



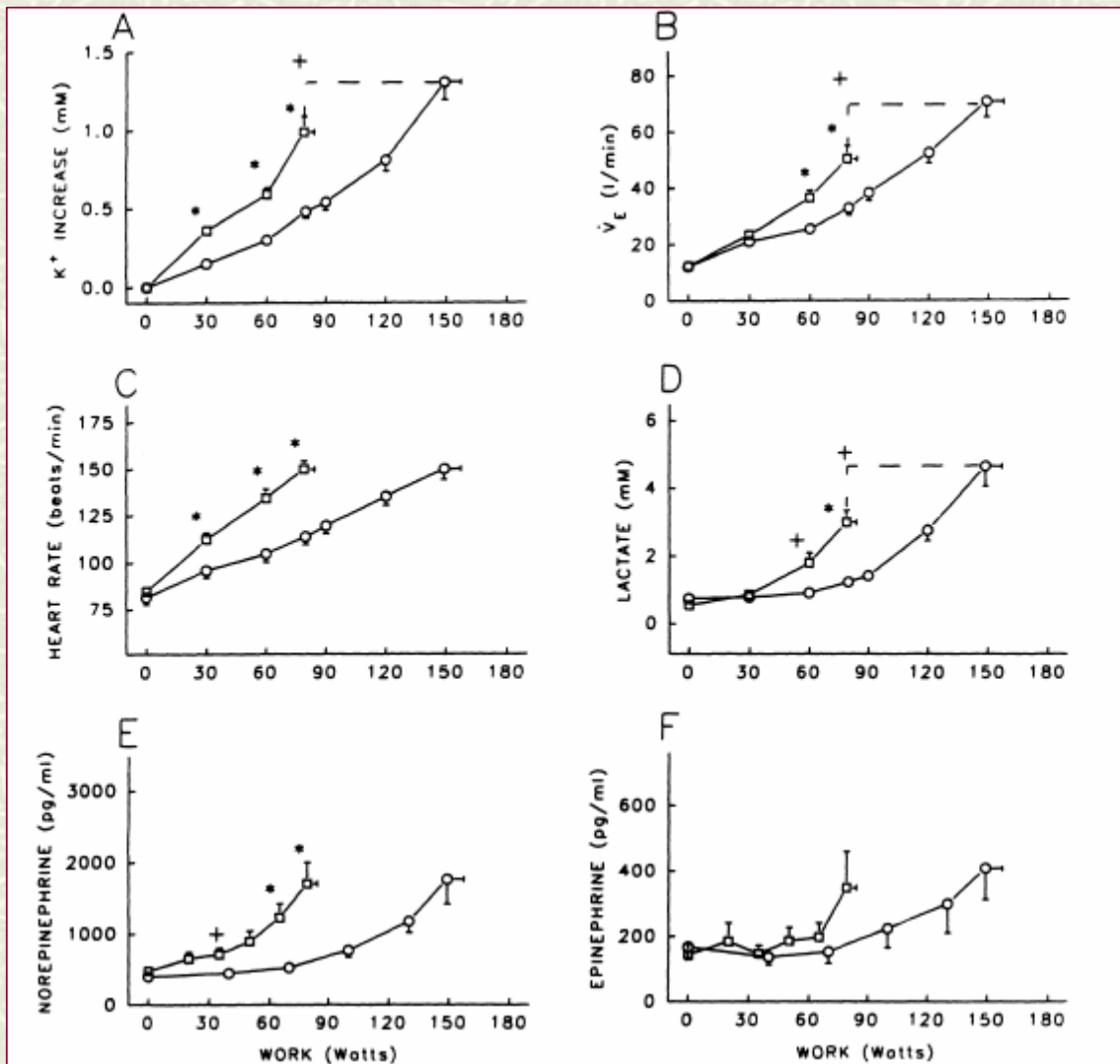
Tono vagale





**Esercizio  
isotonico**

**Esercizio  
isometrico**



↑ [K<sup>+</sup>]



**Modificazioni ECG**  
**Riduzione della fase di plateau del PA**  
**Depressione contrattilità**

↓ pH



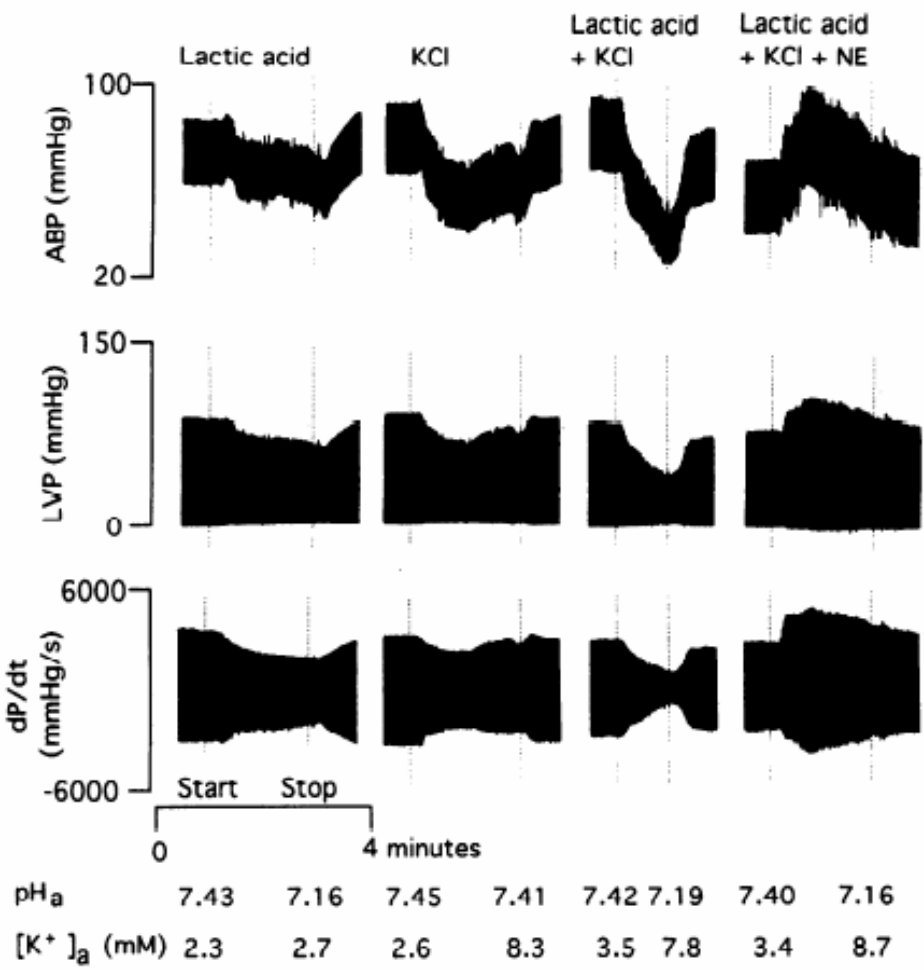
**Depressione contrattilità**  
**Ridotta sensibilità del cuore alle catecoamine**

↑ [catecol.]



**Overload Ca<sup>++</sup> intracellulare e afterdepolarization**

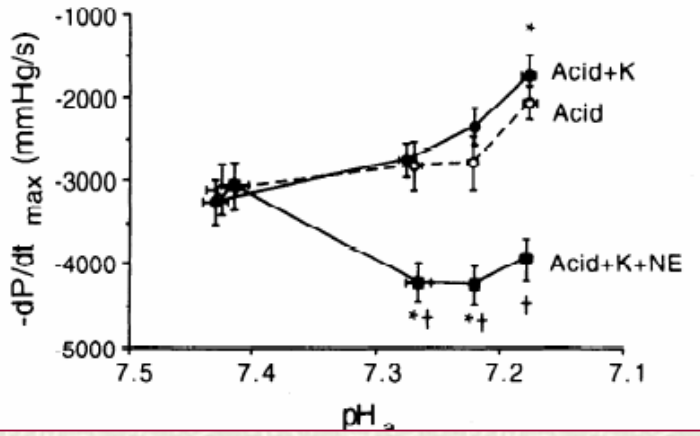
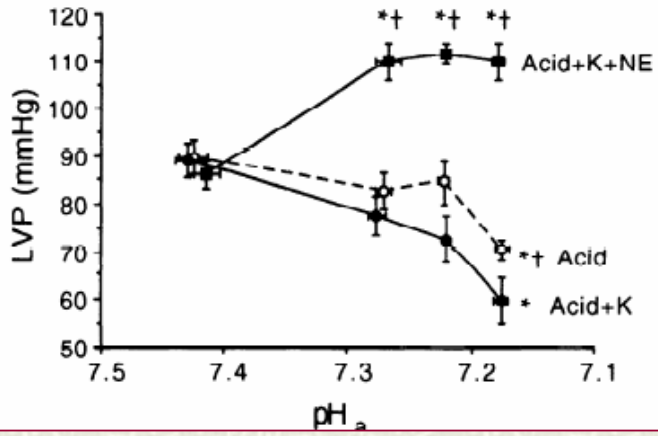
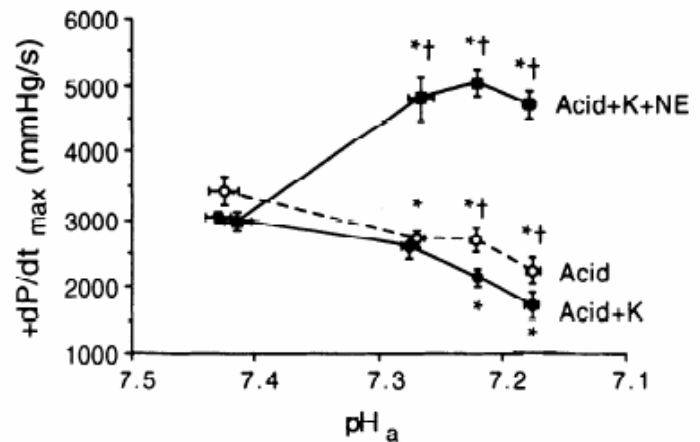
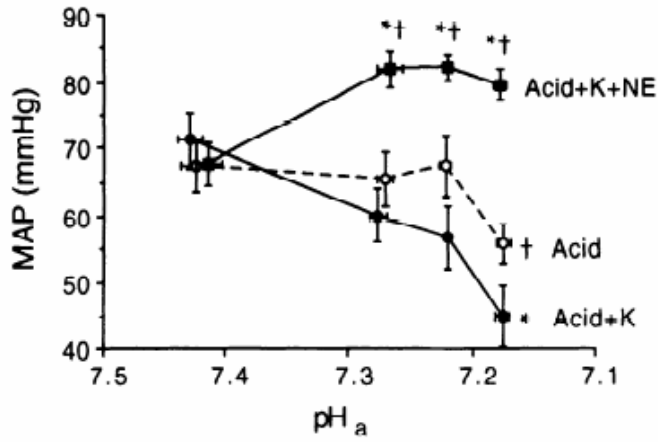




***La stimolazione catecolaminica annulla gli effetti negativi dell'iperkaliemia e dell'acidosi***



### HYPERKALEMIA, ACIDOSIS, AND THE HEART



# Meccanismi antiaritmici in corso di esercizio fisico

- La stimolazione simpatica annulla gli effetti negativi dell'iperkaliemia e dell'acidosi

*Aumento attività pompa sodio-potassio*

*Aumentata conduttanza di membrana agli  $Ca^{2+}$*

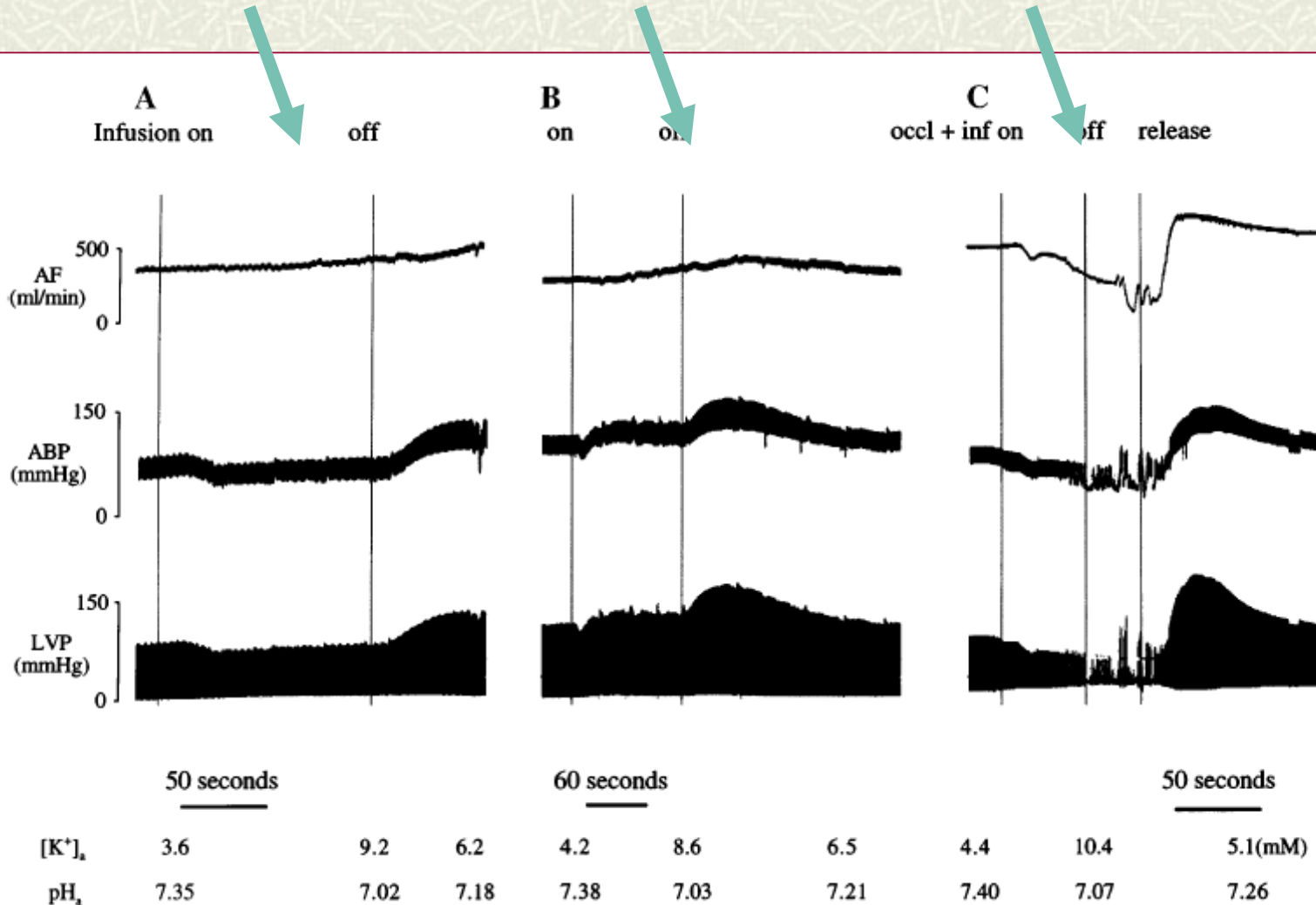
- Sinergismo tra  $Ca^{2+}$  e  $K^+$  durante esercizio
- Elevati valori di  $K^+$  riducono gli effetti proaritmici della stimolazione simpatica.

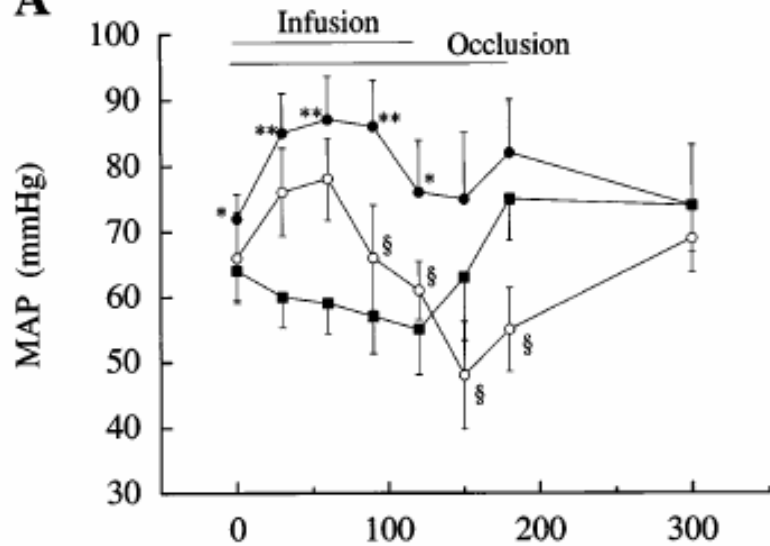
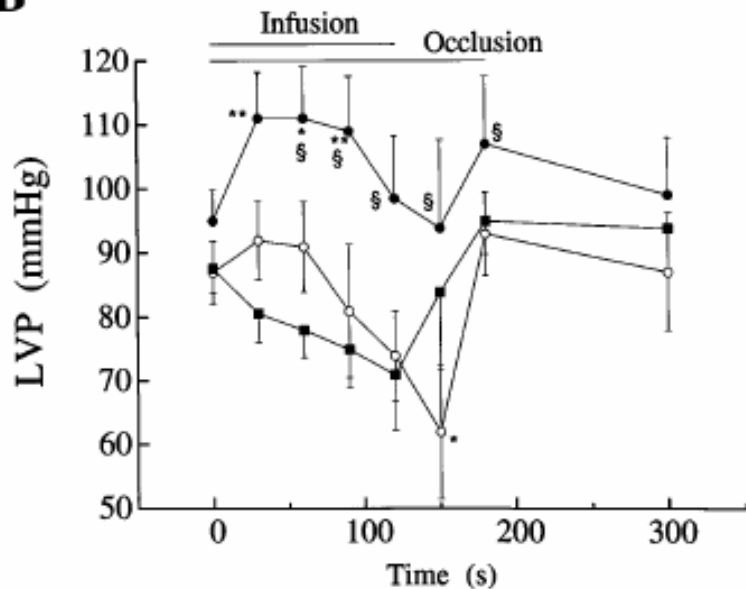


## KCl and lactic acid

## KCl and lactic acid and NE

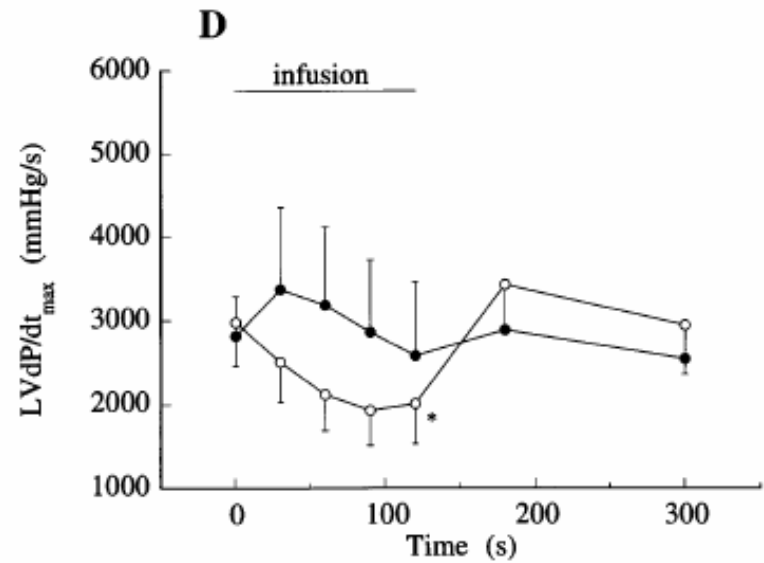
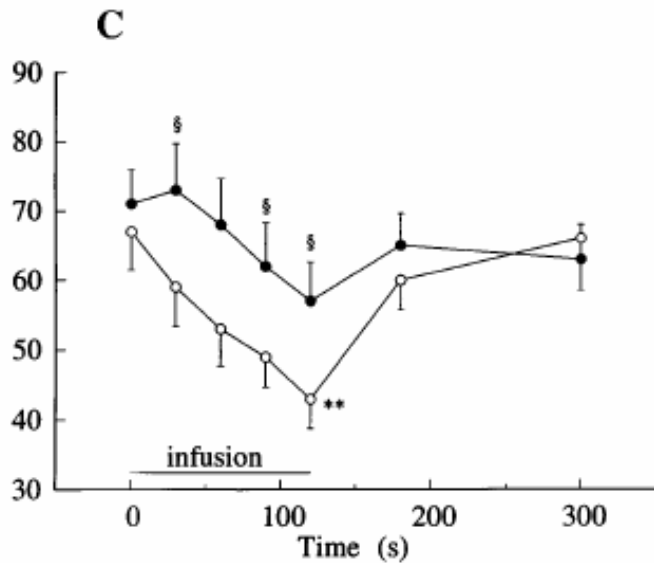
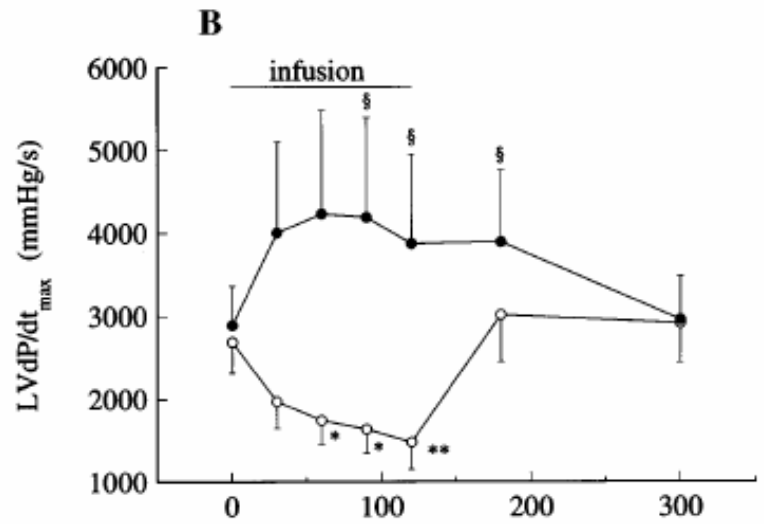
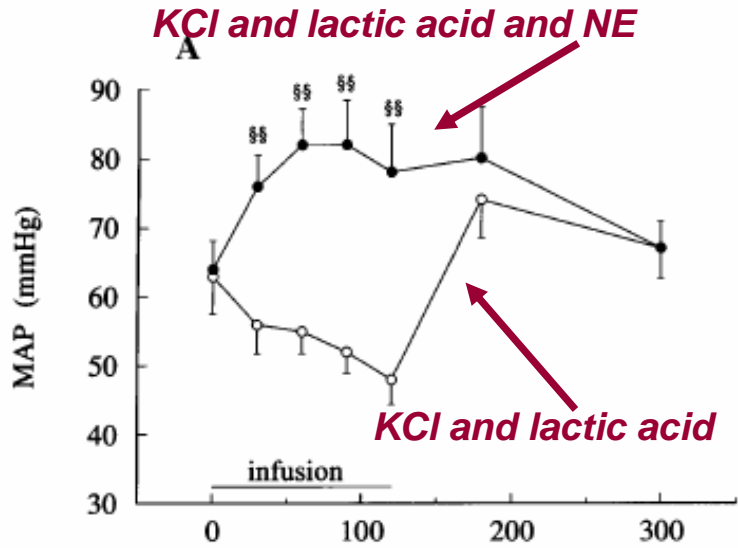
## Ischemia



**A****B**

*L'ischemia acuta riduce l'effetto protettivo delle catecolamine in presenza di iperkaliemia ed acidosi*

# Ischemia



## IMMEDIATE POST-EXERCISE

Abrupt Cessation of Activity      Arterial Vasodilatation

↓ Venous Return

↓ Cardiac Output

↓ Blood Pressure

↓ Coronary Perfusion

Altered Depolarization/Repolarization

↑ Ventricular Ectopic Activity

## ACUTE EXERCISE STRESS

↑ Sympathetic Activity

Na<sup>+</sup>/K<sup>+</sup> Imbalance

↑ Catecholamines

+  
↓ Vagal Stimulation

↑ HR, SBP

↑ MVO<sub>2</sub>

(CHD)

↑ Ischemia

↑ Myocardial Irritability

Altered Conduction Velocity

**6-17% di tutte le morti  
improvvisе avvengono durante  
esercizio**

**Cobb, JACC 86;  
Siscovick NEJM, 1984**

**Burke, JAMA 99;  
Thompson, JAMA 82;**



## **Risk of sudden cardiac arrest during exercise training In the general population**

<b>Study</b>	<b>Activity</b>	<b>Sudden cardiac arrest, event per 100000 person- hours</b>
<b>Vuori,78</b>	<b>Cross-country skiing</b>	<b>1/600000</b>
<b>Gibbons,80</b>	<b>Jogging, swimming, tennis</b>	<b>1/375000</b>
<b>Thompson,82</b>	<b>Jogging</b>	<b>1/396000</b>
<b>Vander,82</b>	<b>Jogging court games</b>	<b>1/888000</b>

**Average**

**1/565000**



# Risk of sudden cardiac arrest during exercise training

## Individuals with known heart disease

Study	Activity	Sudden cardiac arrest, event per 100000 person- hours
Fletcher,77	Jogging	1/6000
Leach,82	Jogging	1/12000
Mead,76	Jogging	1/6000
Hartley,76	Jogging	1/6000
Hossak,82	Jogging	1/65185
Haskell,94	Mixed	1/22028
Van Camp,86	Mixed	1/117333
Franklin, 98	Mixed	1/146127

**Average**

**1/61795**



# Cardiovascular complications of Cardiac Rehabilitation Programs with differing extents of electrocardiographic monitoring

Type of ecg monitoring during exercise sessions	Programs	Patients	Patients-hours	Cardiac-arrests	Fatalities	Myocardial infarction
Continuous	97	28879	888160	9(10.1)	0	4 (4.5)
Intermittent	57	12863	1246111	9 (7.2)	2 (1.6)	3 (2.4)
Graduated	13	9561	217345	3 (13.8)	1 (4.6)	1 (4.8)
<b>Total</b>	<b>167</b>	<b>51303</b>	<b>2351916</b>	<b>21 (8.9)</b>	<b>3 (1.3)</b>	<b>8 (3.4)</b>



# Summary of contemporary exercise based cardiac rehabilitation complication rates

<b>Investigator</b>	<b>Year</b>	<b>Patient Exercise Hours</b>	<b>Cardiac Arrest</b>	<b>MI</b>	<b>Fatal Events</b>
Van Camp	80-84	2.351.926	1/111.996	1/293.990	1/783.972
Digenio	82-88	480.000	1/120.0.00		1/160.000
Vongvanich	86-95	268.503	1/89.501	1/268.503	0/268.503
Beamunt data	82-98	292.254	1/146.127	1/97.418	0/292.254



# Major Cardiovascular Complications during medically supervised exercise in a cardiac rehabilitation Centre (1982-1998)

Patient	Gender	Age	Cardiovascular History	Risk Status	Time in rehabilitation program	Aerobic fitness	Exercise-related cardiovascular complication	Time of event
1	M	31	Anterior MI, EF=29%	High	3	5	MI	8:30 AM
2	F	68	CABGS	Moderate	86	10	MI	8:50 AM
3	M	64	Anterolateral MI, CABGS, EF=20%	High	105	8	VF	9:12 AM
4	M	49	Subendocardial MI, PTCA	Moderate	64	15	MI	5:45 AM
5	M	78	Anterolateral MI, inferoposterior MI CABGS, EF =15%, ICD	High	160	NA	VT	5:20 PM

**Frequenza complessiva di eventi 1/58451 paziente ora**



# Safety of Cardiac rehabilitation in a Medically Supervised Community-Based program

**3511 pts**

**Age 62 yrs**

**338688 patient-hours**

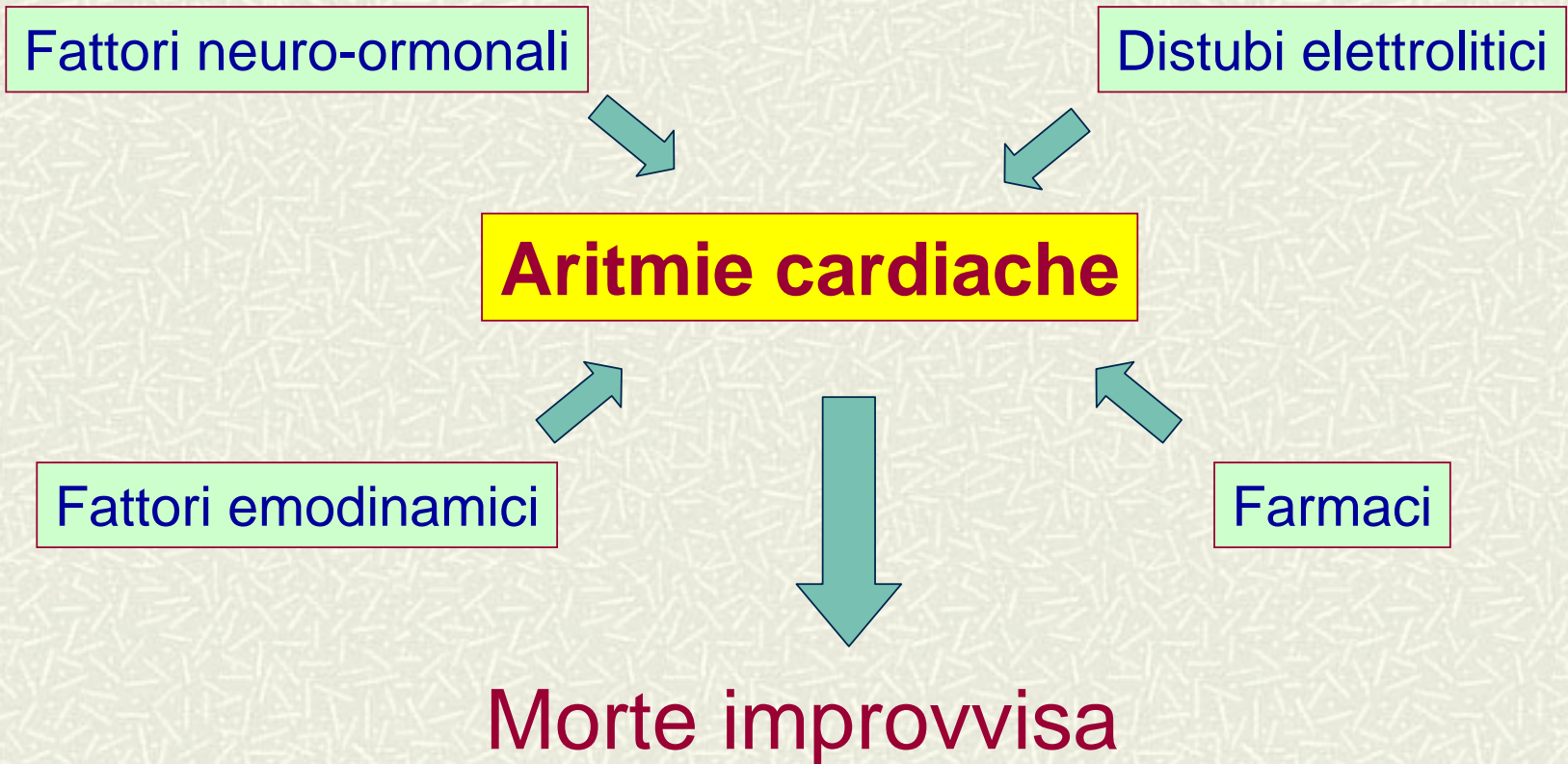
**Event rate: 1/58902 (13 events)**

<b>SVT</b>	<b>5</b>
<b>AF</b>	<b>2</b>
<b>Angina</b>	<b>4</b>
<b>SD</b>	<b>2(1 fatal)</b>

**In 8/13 (62%) l'evento occorreva nelle prime 4 settimane del programma**



# ESERCIZIO E SCOMPENSO CARDIACO



# Eventi avversi durante training fisico in pazienti con scompenso cardiaco

**TABLE 3. Studies on Exercise Training in Chronic HF Due to Systolic Dysfunction: Adverse Events**

Authors (Year of Publication)	No. of Patients	EF, %	Exercise Program		Adverse Events
			Duration, wk	Intensity (% Peak HR or $\dot{V}O_2$ )	
(1) Conn et al (1982) <sup>132</sup>	10	29	5 to 8	70% to 80% HR	None during training
(2) Sullivan et al (1988) <sup>86</sup>	12	24	16 to 24	75% $\dot{V}O_2$	Worsened HF (n=1); exhaustion (n=1)
(3) Jette et al (1991) <sup>56</sup>	7	24	4	70% to 80% HR	Worsened HF (n=3); ventricular tachycardia (n=1)
(4) Meyer et al (1991) <sup>133</sup>	12	23	6	70% to 80% HR	Worsened congestive HF (n=1)
(5) Coats et al (1992) <sup>57</sup>	17	19	8	70% to 80% HR	None during training
(6) Koch et al (1992) <sup>90</sup>	12	26	12	Individualized protocol	None during training
(7) Belardinelli et al (1995) <sup>134</sup>	16	31	8	40% $\dot{V}O_2$	None during training
(8) Belardinelli et al (1995) <sup>58</sup>	36	28	8	60% $\dot{V}O_2$	Atrial fibrillation (n=1); hypotension (n=2)
(9) Hambrecht et al (1995) <sup>59</sup>	12	26	24	70% $\dot{V}O_2$	Atrial arrhythmia (n=1)
(10) Keteyian et al (1996) <sup>60</sup>	15	21	24	60% to 80% HR	None during training
(11) Kavanagh et al (1996) <sup>96</sup>	15	22	52	50% to 60% $\dot{V}O_2$	None during training but worse HF (n=5) after training
(12) Killavuori et al (1996) <sup>135</sup>	12	24	24	50% to 60% $\dot{V}O_2$	Not reported
(13) Wilson et al (1996) <sup>89</sup>	32	23	12	60% to 70% HR	Extreme exhaustion (n=3)
(14) Demopoulos et al (1997) <sup>136</sup>	16	21	12	50% to 80% $\dot{V}O_2$	None during training
(15) Dubach et al (1997) <sup>61</sup>	12	32	8	70% to 80% $\dot{V}O_2$	None during training
(16) Meyer et al (1997) <sup>137</sup>	18	21	3	50% $\dot{V}O_2$	None during training
(17) European Heart Failure Training Group (1998) <sup>74</sup>	134	25	6 to 16	70% to 80% HR	None during training
(18) Hambrecht et al (1998) <sup>37</sup>	10	24	24	70% $\dot{V}O_2$	None during training
(19) Belardinelli et al (1999) <sup>62</sup>	50	28	52	60% $\dot{V}O_2$	None during training
(20) Hare et al (1999) <sup>138</sup>	9	26	11	Resistance training	None during training

HR indicates heart rate (bpm).



# Effect of exercise training in patients with an implantable cardioverter defibrillator

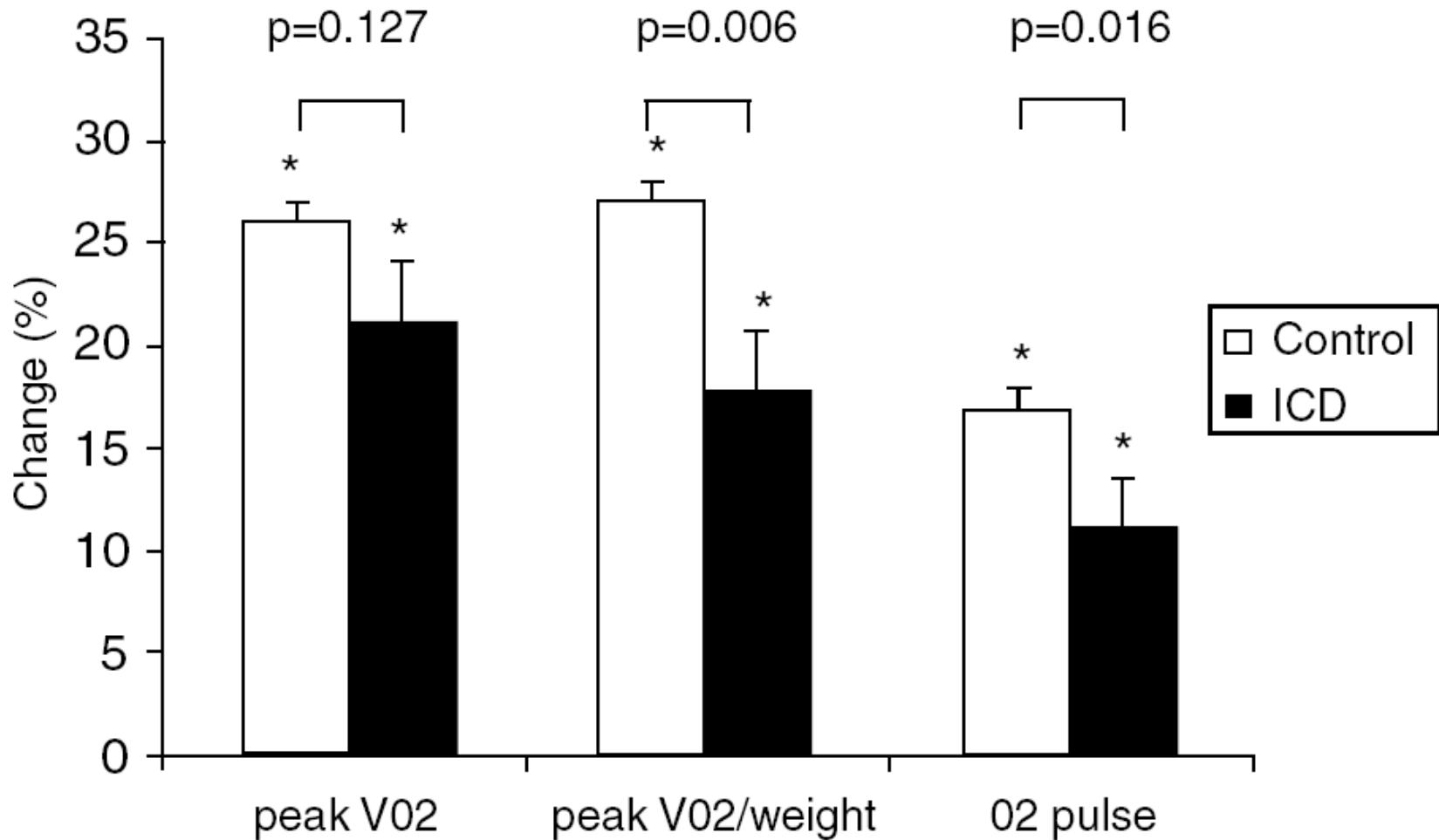
Appropriate ICD interventions for VT in 5 patients during exercise **5.2%**

Between training sessions appropriate discharges occurred in 7 patients **7.2%**

One inappropriate ICD Shock was delivered to a patient in sinus tachycardia during exercise

**1.04%**





# Adverse events during resistance training in patients with chronic heart failure

**Table III.** Adverse events during resistance training in patients with chronic heart failure

Study	No. of patients	Age (y)	EF (%)/NYHA class	Type of training	Adverse events
Magnusson et al. <sup>[16]</sup> (1996)	5	57	11	Segmental (localised) muscular training using free weights	Intermittent atrial fibrillation (n = 1)
Hare et al. <sup>[17]</sup> (1999)	9	63	26/II–III	Whole body training (CWT)	None
Barnard et al. <sup>[22]</sup> (2000)	14	55	25	Whole body training (CWT)	None
Maiorana et al. <sup>[23]</sup> (2000)	13	60	26/II–III	Whole body training (CWT)	None
Pu et al. <sup>[18]</sup> (2001)	16	77	36/2.2	Whole body training (CWT)	None
Grosse et al. <sup>[19]</sup> (2001)	14	56	28/3.0	Segmental (localised) muscular training using hand-held weights (weight collars)	None
Tynni-Lenné et al. <sup>[20]</sup> (2001)	16	63	30/II–III	Segmental (localised) muscular training using elastic bands	Increased oedema (n = 1)
Conraads et al. <sup>[26]</sup> (2002)	23	57	27/I–IV	Whole body training (CWT)	Not reported
Delagardelle et al. <sup>[27]</sup> (2002)	10	56	27/2.7	Segmental (localised) muscular training using machines and dumb bells	None
Selig et al. <sup>[28]</sup> (2004)	19	65	27/2.4	Whole body training (CWT)	Sudden death (n = 1), noncardiac illness (n = 1)

**CWT** = circuit weight training; **EF** = ejection fraction; **NYHA** = New York Heart Association.



**Stratificazione del rischio nei pazienti che afferiscono ad un programma di riabilitazione**



- Anamnesi
- Visita
- ECG a riposo
- ECG da sforzo
- Ecocardiografia
- Holter monitoring
- ECO stress
- Cateterismo destro



**Ischemia  
Disfunzione VS  
Aritmie**



# Risk Classification for Exercise Training

## Class A: Apparently Healthy individuals

---

This classification includes:

1. Children, adolescents, men  $<45$  years, and women  $<55$  years who have no symptoms or known presence of heart disease or major coronary risk factors.
2. Men  $\geq 45$  years and women  $\geq 55$  years who have no symptoms or known presence of heart disease and with  $<2$  major cardiovascular risk factors.
3. Men  $\geq 45$  years and women  $\geq 55$  years who have no symptoms or known presence of heart disease and with  $\geq 2$  major cardiovascular risk factors.



# Risk Classification for Exercise Training

## Class A: Apparently Healthy individuals

Activity guidelines: No restrictions other than basic guidelines.

Supervision required: None\*.

ECG and blood pressure monitoring: Not required.

---

\*It is suggested that persons classified as Class A-2 and particularly Class A-3 undergo a medical examination and possibly a medically supervised exercise test before engaging in vigorous exercise.



# Risk Classification for Exercise Training

## Class B: Presence of Known stable Cardiovascular Disease with Low risk for complications with vigorous Exercise

1. CAD (MI, CABG, PTCA, angina pectoris, abnormal exercise test, and abnormal coronary angiograms) whose condition is stable and who have the clinical characteristics outlined below
2. Valvular heart disease, excluding severe valvular stenosis or regurgitation with the clinical characteristics as outlined below
3. Congenital heart disease; risk stratification for patients with congenital heart disease should be guided by the 27th Bethesda Conference recommendations<sup>145</sup>
4. Cardiomyopathy: ejection fraction  $\leq 30\%$ ; includes stable patients with heart failure with clinical characteristics as outlined below but not hypertrophic cardiomyopathy or recent myocarditis
5. Exercise test abnormalities that do not meet any of the high risk criteria outlined in class C below

Clinical characteristics (must include all of the following)

1. New York Heart Association class 1 or 2
2. Exercise capacity  $\leq 6$  METs
3. No evidence of congestive heart failure
4. No evidence of myocardial ischemia or angina at rest or on the exercise test at or below 6 METs
5. Appropriate rise in systolic blood pressure during exercise
6. Absence of sustained or nonsustained ventricular tachycardia at rest or with exercise
7. Ability to satisfactorily self-monitor intensity of activity



# **Risk Classification for Exercise Training**

## **Class B: Presence of Known stable Cardiovascular Disease with Low risk for complications with vigorous Exercise**

Activity guidelines: Activity should be individualized, with exercise prescription provided by qualified individuals and approved by primary healthcare provider.

Supervision required: Medical supervision during initial prescription session is beneficial.

Supervision by appropriate trained nonmedical personnel for other exercise sessions should occur until the individual understands how to monitor his or her activity. Medical personnel should be trained and certified in Advanced Cardiac Life Support. Nonmedical personnel should be trained and certified in Basic Life Support (which includes cardiopulmonary resuscitation).

ECG and blood pressure monitoring: Useful during the early prescription phase of training, usually 6 to 12 sessions.



# Risk Classification for Exercise Training

## Class C: Those at Moderate-to-high Risk for Cardiac Complications During Exercise

1. CAD with the clinical characteristics outlined below.
2. Valvular heart disease, excluding severe valvular stenosis or regurgitation with the clinical characteristics as outlined below.
3. Congenital heart disease; risk stratification for patients with congenital heart disease should be guided by the 27th Bethesda Conference recommendations.<sup>145</sup>
4. Cardiomyopathy: ejection fraction <30%; includes stable patients with heart failure with clinical characteristics as outlined below but not hypertrophic cardiomyopathy or recent myocarditis.
5. Complex ventricular arrhythmias not well controlled.

Clinical characteristics (any of the following):

1. NYHA class 3 or 4.
2. Exercise test results
  - Exercise capacity <6 METs
  - Angina or ischemic ST depression at a workload <6 METs
  - Fall in systolic blood pressure below resting levels during exercise
  - Nonsustained ventricular tachycardia with exercise
3. Previous episode of primary cardiac arrest (ie, cardiac arrest that did not occur in the presence of an acute myocardial infarction or during a cardiac procedure).
4. A medical problem that the physician believes may be life-threatening



# Risk Classification for Exercise Training

## Class C: Those at Moderate-to-high Risk for Cardiac Complications During Exercise

Activity guidelines: Activity should be individualized, with exercise prescription provided by qualified individuals and approved by primary healthcare provider

Supervision: Medical supervision during all exercise sessions until safety is established.

ECG and blood pressure monitoring: Continuous during exercise sessions until safety is established, usually  $\geq 12$  sessions.



# Risk Classification for Exercise Training

## Class D: Unstable Disease With Activity Restriction

1. Unstable ischemia.
2. Severe and symptomatic valvular stenosis or regurgitation.
3. Congenital heart disease; criteria for risk that would prohibit exercise conditioning in patients with congenital heart disease should be guided by the 27th Bethesda Conference recommendations.<sup>145</sup>
4. Heart failure that is not compensated.
5. Uncontrolled arrhythmias.
6. Other medical conditions that could be aggravated by exercise.



# Risk Classification for Exercise Training

## Class D: Unstable Disease With Activity Restriction

Activity guidelines: No activity is recommended for conditioning purposes. Attention should be directed to treating the patient and restoring the patient to Class C or better. Daily activities must be prescribed on the basis of individual assessment by the patient's personal physician.



**La popolazione dei pazienti che afferiscono ai programmi riabilitativi è sempre più caratterizzata da :**

- Età più avanzata**
- Più frequenti comorbidità**
- Grave disabilità**

**E' sufficiente la valutazione cardiologica per stratificare il rischio correlato alle procedure riabilitative?**



# Optimizing Risk stratification in Cardiac Rehabilitation with inclusion of a comorbidity Index

Stratificazione  
di rischio  
“cardiologica”

**ARSE**

OR 1.56 (1.14-2.12)

Stratificazione  
di rischio per  
comorbidità

**CMI**

OR 1.23(1.03-1.47)



# Stratificazione del rischio nei pazienti che afferiscono ad un programma di riabilitazione

- Anamnesi
- Visita
- ECG a riposo
- ECG da sforzo
- Ecocardiografia
- Holter monitoring
- ECO stress
- Cateterismo destro

- Presenza di comorbidità (polmonari, endocrine, renali e neurologiche)
- Patologie muscolo-scheletriche
- Stato nutrizionale
- Stato psicosociale

**Valutazione multidimensionale del rischio**

