Venicearrhythmias 2015
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Sports and Physical Exercise in Special Clinical Settings: ICD Patients

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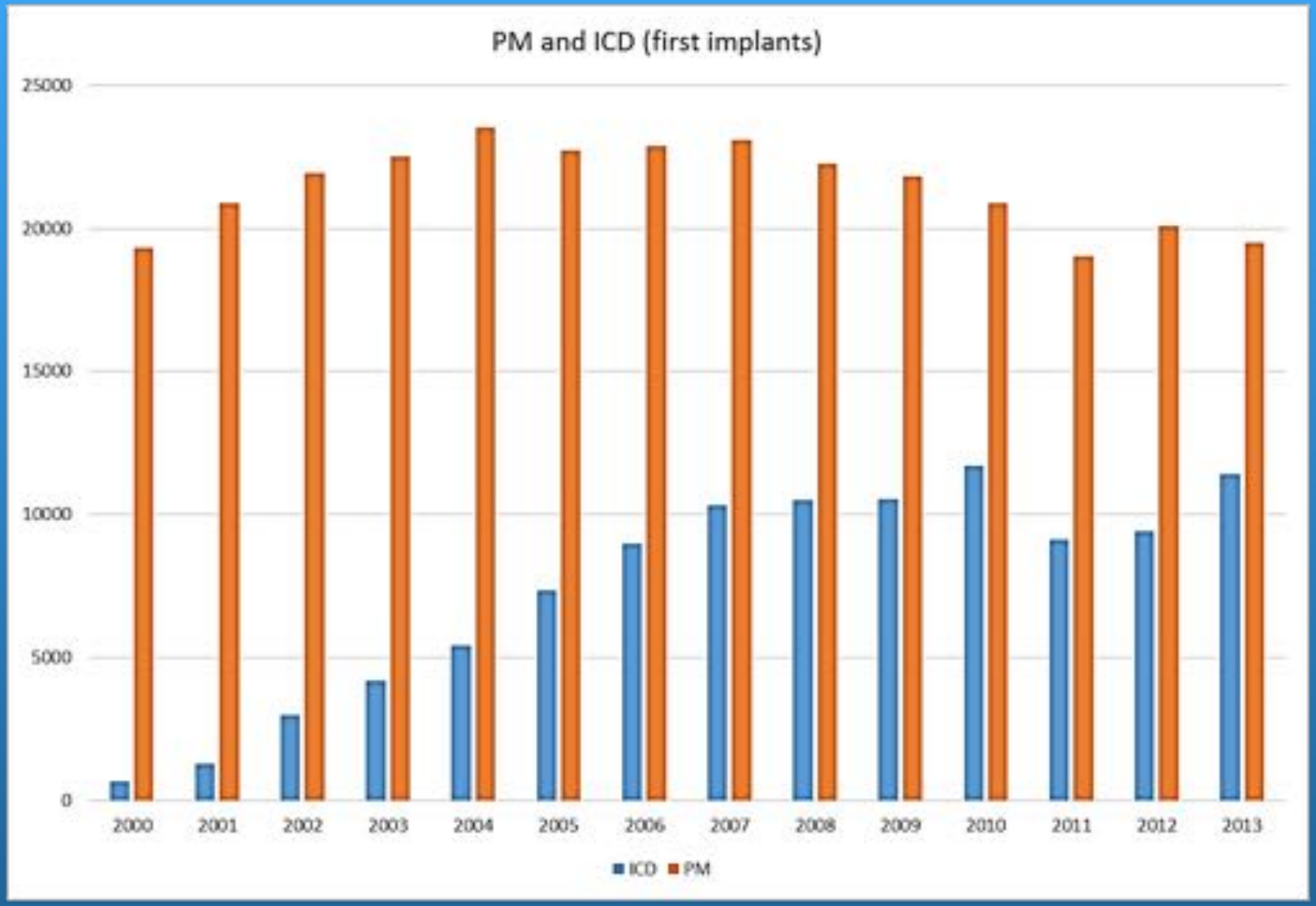
PA patients/athletes with ICDs
Key Points

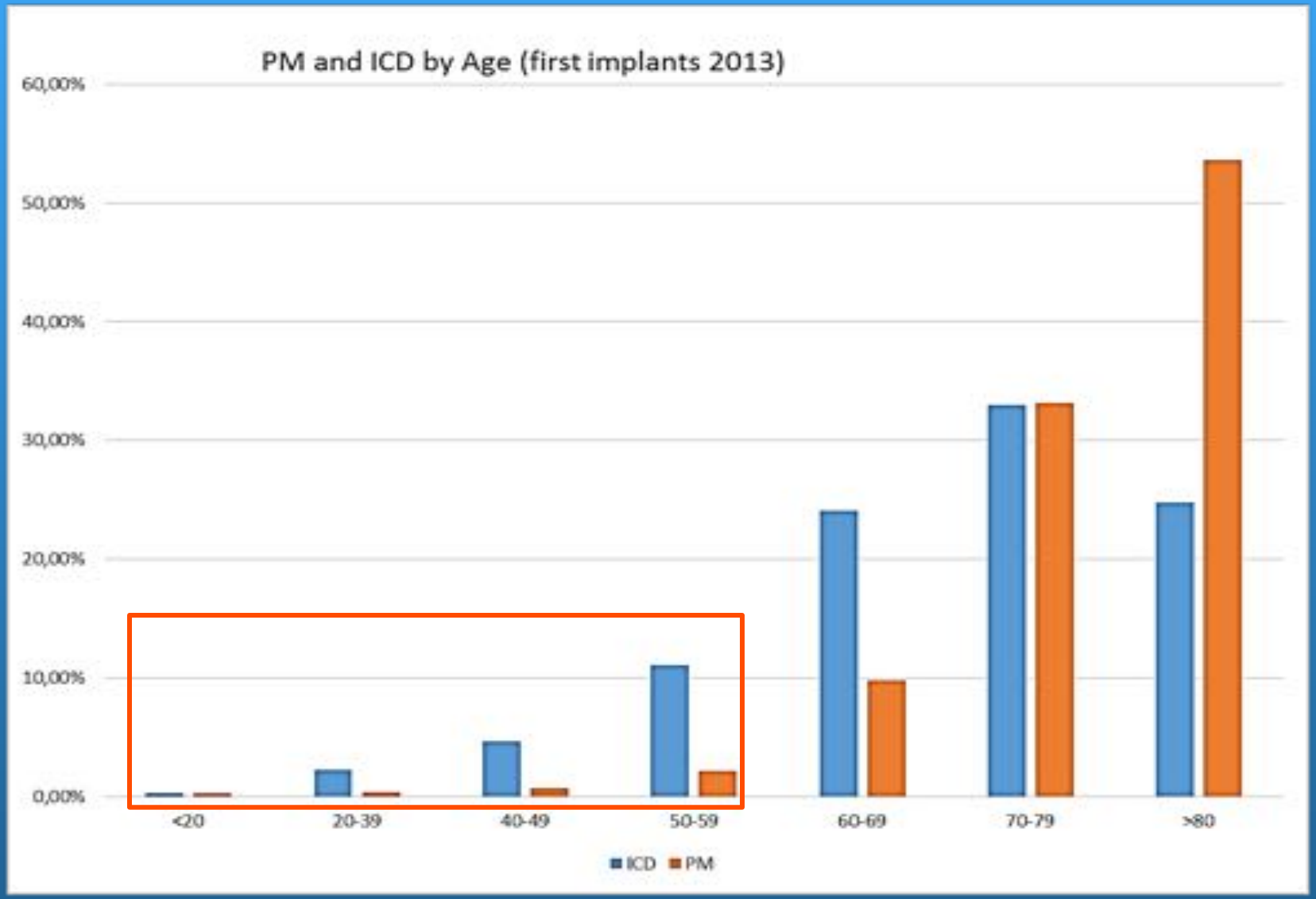
- How many PA pts/athletes have ICD
- What guidelines say regarding this isssue
- Concern about eligibility to PE/sports in ICD pts
- How to manage PA pts/athletes with ICDs

First PM and ICD implants in Italy



Proclemer et al. AIAC - Italian PM-ICD Registry

First PM and ICD implants in Italy per decades in 2013



Proclemer et al. AIAC - Italian PM-ICD Registry

ICDs in PA pts/athletes

- ICDs are not so uncommon in PA/sports population

- As understanding of genetic predisposition to SCD improves, the use of ICDs in a young-adult subjects without SHD and potentially interested in sports/PA will became an increasingly common issue

Guidelines for athletes with ICDs
Criteria for Sports eligibility

- *"Normal" heart*
- *No contact sports:* boxing; rugby, american football
- *No sports where TLOC dangerous to athlete or others*: driving; rock climbing
- *Only low intensity sports activities:* golf, bowling

Safety of Sports Participation in Patients with Implantable Cardioverter Defibrillators: A Survey of Heart Rhythm Society Members

JCE 2006

RACHEL LAMPERT, M.D.,* DAVID CANNOM, M.D.,† and BRIAN OLSHANSKY, M.D.‡

From the *Yale University School of Medicine, Department of Medicine, New Haven, Connecticut, USA, †Los Angeles Cardiology Associates, Los Angeles, California, USA, and ‡University of Iowa School of Medicine, Department of Medicine, Iowa City, Iowa, USA

Are guidelines followed ?

A retrospective survey in 614 physicians in USA

- Only 10% physicians advised avoiding activities more strenuous than golf or bowling
- 76% advised against contact sports
- 45% advised against competitive sports
- 42% had 1 or more ICD pts engaged in competitive sports

Safety of Sports Participation in Patients with Implantable Cardioverter Defibrillators: A Survey of Heart Rhythm Society Members

A survey in 614 physicians

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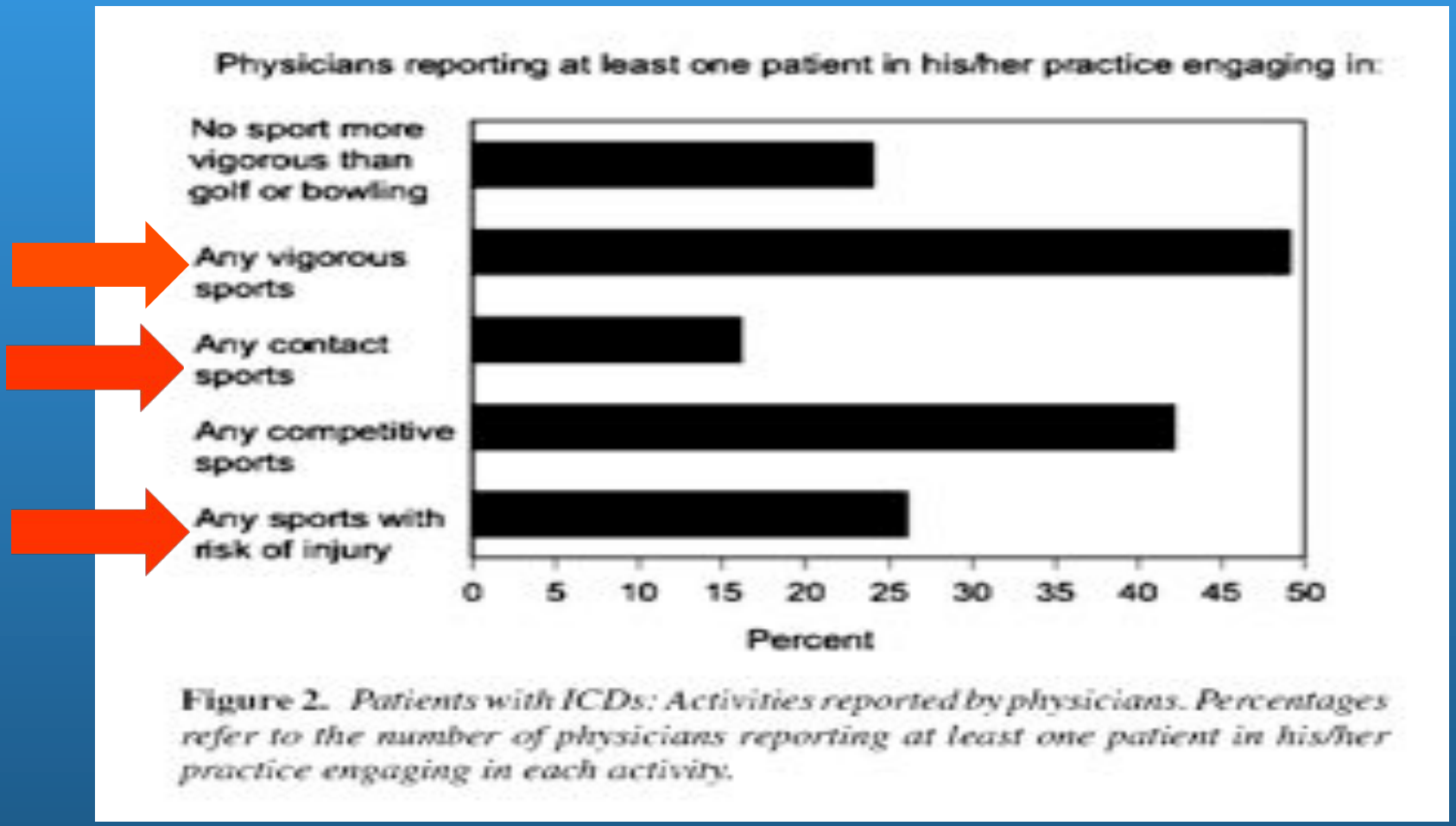

Figure 2. *Patients with ICDs: Activities reported by physicians. Percentages refer to the number of physicians reporting at least one patient in his/her practice engaging in each activity.*

Leisure-Time Activities of Patients with ICDs: Findings of a Survey with Respect to Sports Activity, High Altitude Stays, and Driving Patterns

RICHARD KOBZA, M.D.,* FIRAT DURU, M.D.,† and PAUL ERNE, M.D.*

From the *Division of Cardiology, Cantonal Hospital, Luzern, Switzerland, and †Clinic for Cardiology, University Hospital, Zurich, Switzerland

A retrospective survey in 387 pts in Switzerland

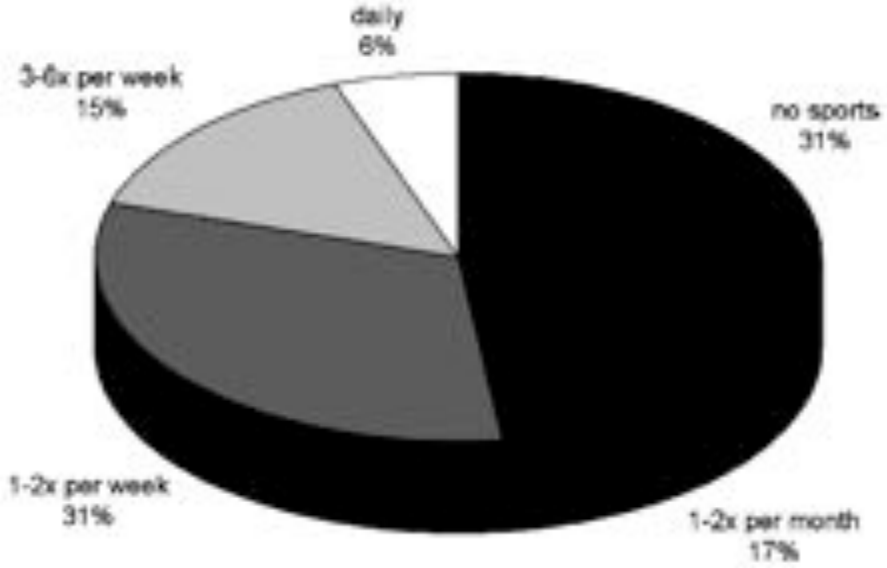

Figure 1. *Frequency of sporting activity before ICD implantation.*

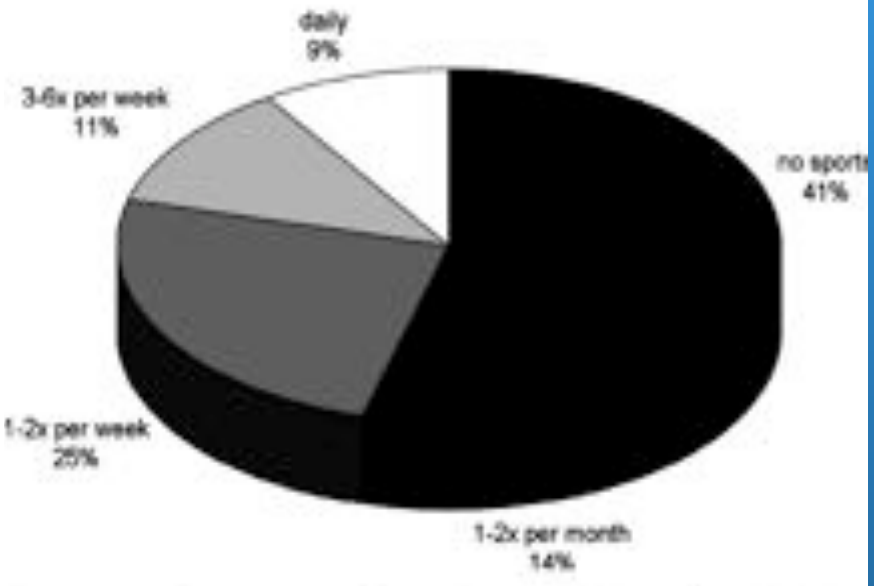

Figure 2. *Frequency of sporting activity after ICD implantation.*

PACE 2008

56 % of pts reported a stay at altitudes higher than 2000 meters on sea level

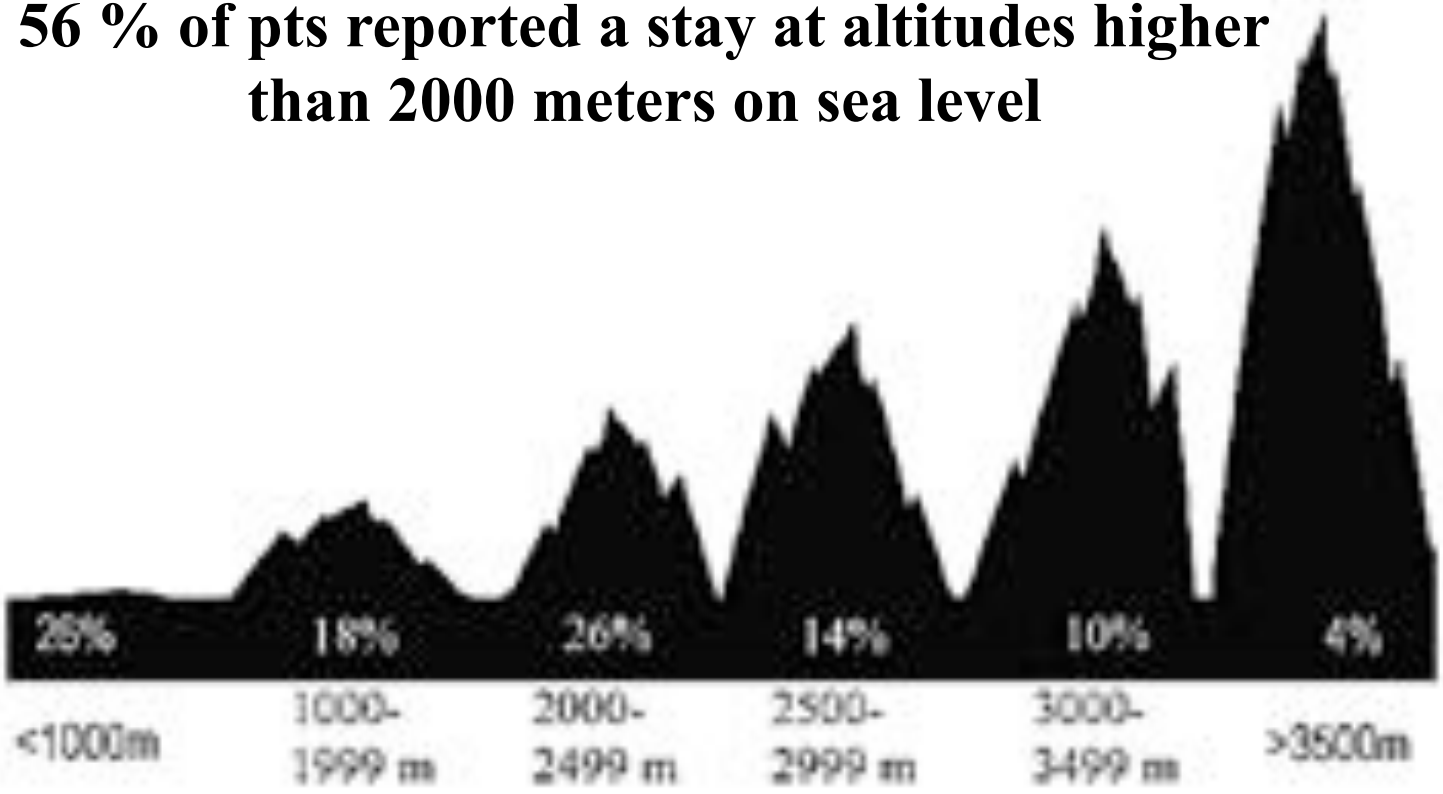

Figure 4. *High-altitude stays of study patients.*

Mismatch between guidelines and real world

What are the reasons ?

- Concerns about consequences of unnecessary disqualification from sports
- Feeling that the sports-related risk in ICD recipiens are overextimated

Problems Related to an Unnecessary Disqualification from Sports in ICD pts

- **Deprivation of health benefits of physical exercise (confirmed also in ICD patients !)**
- Psychological burden
- Economic burden in professional athletes

Are sports-related risks in ICD pts overextimated ?

- ***Risk of damage to the device & leads*** during contact sports
- ***Consequence of TLOC ± ICD shock*** during intrinsic risk sports
- ***Risk of failure of shock therapy*** during exercise because of metabolic, autonomic and ischemic changes
- ***Inappropriate shocks*** because of exercise-induced sinus tachycardia and SVT
- ***Increased frequency of VAs and shocks with intense exercise***

Lampert et al. JCE 2006

Table 1 Adverse events reported due to arrhythmia or shock during sports participation

Adverse event	N
System Damage	
Lead Fracture/Dislodgement	
Repetitive motion activities (total)	28
Weight-lifting	16
Golf	5
Tennis	2
Wood-chopping, swimming, waterskiing, hunting, "hanging from monkey bars"	1 each
Direct trauma (total)	10
Football	3
Basketball, hockey, biking, skiing, hit by golf ball, baseball, wrestling	1 each
No details given	6
Generator Damage (hit by softball)	1

Lampert et al. JCE 2006

Table 1 Adverse events reported due to arrhythmia or shock during sports participation

Adverse event	N
Patient Injury	
Minor injuries ("bruising, lacerations, soft tissue injury") (total)	6
Fall from bicycle	3
Fall due to syncope during golf, running, nonspecified	1 each
Major injuries (total)	3
Syncopal on treadmill with subdural hematoma	1
Syncopal while running with head injury	1
Fall during hunting with neck injury	1
Shock Failure/Multiple Shocks (Total)	4
Running	2
Football, basketball	1 each

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A survey in 614 physicians in USA

- 40 % of physicians reported shocks during sports
- Only 2 cases of shock failure (1 in pt treated with IC AAD and 1 after heavy alcohol ingestion)

Leisure-Time Activities of Patients with ICDs: Findings of a Survey with Respect to Sports Activity, High Altitude Stays, and Driving Patterns

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From the *Division of Cardiology, Cantonal Hospital, Luzern, Switzerland, and †Clinic for Cardiology, University Hospital, Zurich, Switzerland

A survey in 387 pts in Switzerland

- 17% of pts who regularly performed sports after ICD implantation experienced shock during exercise
- Annual probability of an ICD shock during sports: 3.3% (similar to that reported in unselected sedentary ICD populations)

PACE 2008

Circulation
JOURNAL OF THE AMERICAN HEART ASSOCIATION

American Heart Association

Circulation 2013

Safety of Sports for Athletes With Implantable Cardioverter-Defibrillators : Results of a Prospective, Multinational Registry

Rachel Lampert, Brian Olshansky, Hein Heidbuchel, Christine Lawless, Elizabeth Saarel, Michael Ackerman, Hugh Calkins, N.A. Mark Estes, Mark S. Link, Barry J. Maron, Frank Marcus, Melvin Scheinman, Bruce L. Wilkoff, Douglas P. Zipes, Charles I. Berul, Alan Cheng, Ian Law, Michele Loomis, Cheryl Barth, Cynthia Brandt, James Dziura, Fangyong Li and David Cannom

- International prospective registry
- 372 pts/athletes (mean age 33 yrs) implanted with ICD both for primary and secondary prevention, who continued to practice sports/PE, with a median F-U of 31 months

Lampert et al. Circulation 2013

Table 1. Demographic and Clinical Characteristics

	Entire Cohort (n=372)	Competitive Subgroup (Varsity/Junior Varsity/Traveling Teams; n=60)
Cardiac diagnosis, n (%)		
Long-QT syndrome	73 (20)	28 (47)
Hypertrophic CM	65 (17)	13 (22)
Arrhythmogenic right ventricular dysplasia	53 (14)	3 (5)
Coronary artery disease	41 (11)	0
Idiopathic VT/VF (normal heart)	40 (11)	2 (3)
Dilated cardiomyopathy	31 (8)	0
Congenital heart disease	30 (8)	6 (10)
Catecholaminergic polymorphic VT	10 (3)	3 (5)
Brugada syndrome	7 (2)	1 (2)
Valvular heart disease	6 (2)	0
Left ventricular noncompaction	5 (1)	1 (2)
None, family history	5 (1)	1 (2)
Other	6 (2)	2 (4)

Lampert et al. Circulation 2013

Table 1. Demographic and Clinical Characteristics

	Entire Cohort (n=372)	Competitive Subgroup (Varsity/Junior Varsity/Traveling Teams; n=60)
ICD indication		
Ventricular fibrillation/cardiac arrest, n (%)	102 (27)	15 (25)
Sustained VT, n (%)	53 (14)	1 (2)
Syncope, n (%)	99 (27)	25 (42)
Prophylactic–CAD/CM, n (%)†	32 (9)	0
Prophylactic–other, n (%)	65 (17)	17 (29)
Positive electrophysiology study, n (%)	21 (6)	2 (3)
Time since initial ICD implantation, mo	27 (12–59)	16 (8–28)
ICD rate cutoff, bpm‡	200 (188–215)	217 (210–222)
Primary prevention, bpm	201 (188–219)	
Secondary prevention, bpm	200 (187–210)	
Ejection fraction, %	60 (50–66)	67 (60–72)
Taking β-blocking agents, n (%)	223 (62)	40 (67)

CAD indicates coronary artery disease; CM, cardiomyopathy; ICD, implantable cardioverter-defibrillator; VF, ventricular fibrillation; and VT, ventricular tachycardia. Values are either number (percent) or median (interquartile range) as appropriate.

Lampert et al. Circulation 2013

Table 2. Sports Participation

Sports	Total, n	Pre–High School, n	High School, n	College, n	Postgraduate, n	Competitive Subgroup* (Varsity/Junior Varsity/ Traveling Team), n
Baseball	18	6	8	3	1	11
Basketball	56	7	15	14	20	23
Cycling	39			2	37	1
Equestrian	3		1		2	1
Field hockey	1		1			1
Football, flag	13		3	6	4	5
Football, tackle	6		3	1	2	2
Hockey	6				6	
Lacrosse	4		2	2		4
Racquetball	5				5	
Rock climbing	7		1	1	5	
Running						
Track/field	12	1	11			12
Cross-country	4		2	1	1	2
Marathon	19				19	
Running (other)	71		1	5	65	5
Skiing	71	1	4	2	64	1
Snowboarding	15		2	7	6	2
Soccer	69	6	13	11	39	19
Softball	34		4	5	25	6
Squash	6				6	
Surfing	13		1	2	10	2
Swimming	10		3		7	4
Tennis	39		7	2	30	7
Triathlons	24			2	22	2
Ultimate Frisbee	3			2	1	1
Volleyball	27	2	6	7	12	11
Wrestling	1		1			1

Lampert et al. Circulation 2013

Primary End Point

There were no occurrences of the primary end point (tachyarrhythmic death or externally resuscitated tachyarrhythmia during or after sports participation or severe injury resulting from arrhythmia-related syncope or shock during sports).

ICD terminated all arrhythmic episodes !

Lampert et al. Circulation 2013

Secondary End Point: Moderate Injury

There were no moderate injuries related to arrhythmias or shocks received during sports.

Secondary End Point: System Malfunction

There were 13 definite and 14 possible lead malfunctions. The estimated lead survival free of definite malfunction (from implantation date) was 97% at 5 years and 90% at 10 years; the rate of survival free of definite plus possible malfunction was 93% at 5 years and 84% at 10 years (Figure [A and B]). There were no generator malfunctions.

Similar to that reported in unselected sedentary ICD populations

Lampert et al. Circulation 2013

Table 3. Number of Shock Events and of Individuals Receiving Shocks, Total Cohort

Rhythm	Competition Related, n*	Physical Activity Related, n†	Other, n	Total, n (%)
Ventricular tachycardia	22/16	14/11	11/8	47/35 (9)
Ventricular fibrillation	8/6	3/3	10/5	21/14 (4)
Sinus tachycardia	7/6	6/3	1/1	14/10 (3)
Atrial fibrillation	5/3	10/6	3/3	18/12 (3)
Other supraventricular tachycardia	2/2	2/2	0/0	4/4 (1)
Noise	0/0	2/2	6/5	8/7 (2)
T-wave oversensing	2/2	1/1	1/1	4/4 (1)
Other	3/2	1/1	1/1	5/4 (1)
Total, n (%)	49/36 (10)	39/29 (8)	33/23 (6)	121/77 (21)

Values refer to number of events/number of unique individuals. Percents refer to percent of the study population. Eighteen shocks did not have

- At least 1 appropriate shock in 13 % of pts
- At least 1 inappropriate shock in 11 % of pts
- Both appropriate and inappropriate shocks were more frequent during sports/PE versus rest , without any differences between competive vs non competitive athletes

Lampert et al. Circulation 2013

Table 5. Events/Individuals Requiring >1 Shock for Termination to Sinus Rhythm

Sex	Age, y	Cardiac Diagnosis	Primary Sport	Activity	Activity Type	Shocks, n
M	28	Idiopathic VF	Ultimate Frisbee	Ultimate Frisbee	Competition	5
F	47	Idiopathic VF	Cycling	Cycling	Practice	4
M	44	CAD	Running	Running	Practice	2
M	50	CAD	Cycling	Cycling	Practice	6
M	57	CAD	Tennis, basketball	Walking	Physical Activity	6
F	16	CPVT	Lacrosse field hockey	Running	Post–physical activity	3
				Running	Post–physical activity	4
M	15	HCM	Baseball	Socializing	Other	2

CAD indicates coronary artery disease; CPVT, catecholaminergic polymorphic ventricular tachycardia; HCM, hypertrophic cardiomyopathy; and VF, ventricular fibrillation.

- 7 athletes required more than 1 shock for arrhythmia termination: 6 during sports/PE and 1 at rest
- The majority of athletes who experienced shocks during sports chose to continue playing

ICD in PA pts/athletes: Real Concerns

- Sports-related device trauma/malfunctions seem quite rare
- Athletes' injuries due to shocks during sports seem rare
- Shock therapy for exercise-related arrhythmias seems effective
- **Appropriate and inappropriate shocks increase during sports**

Negative consequences of shocks

- Shocks are painful: anxiety, reduction of QOL
- Inappropriate shocks may be potentially life-threatening (triggers of malignant arrhythmias)
- Lifetime prognosis is worsen by multiple shocks

Mismatch between guidelines and real world

What are the possible solutions ?

- ***Correct clinical management of PA pts/athletes with ICD***
- ***Future revision of guidelines***

Correct clinical management of PA pts/athletes with ICD: 3 questions

- ***What kind of CVD is present ?*** CVD is the main determinant of prognosis: need of a patient tailored evaluation

- ***What is the individual risk to benefit ratio of exercise ?***

- ***How to reduce the potential sports-related risks in athletes with ICDs ?***

Risk-to-benefit ratio of exercise

- ***Exercise exacerbates arrhythmias in every setting***

- ***Training reduces the overall risk of SCD in adult individuals with CAD:*** the benefits of physical exercise outweight the risks

- ***Does training improve the prognosis also in young individuals with arrhythmogenic HD ?*** Moreover, physical exercise may increases the risk of disease progression (HCM, ARVC)

How to reduce the potential risks related to sports in athletes with ICDs ?

Theoretic Possibilities

- related to implantation modality
- related to leads and device selection
- related to device programming

Levels of Evidence C: *device selection and programming must be tailored first according to the patient's specific CV condition*

Issues Regarding Implantation Modality

- ***Right or left subclavear side:*** depending on arm dominance and type of sport/PA (e.g. left side in right-handed tennis player)

- ***Use of cephalic vein:*** in order to reduce the risk of lead fracture due to subclavian crush (?)

- ***Avoid repetitive ipsilateral arm movements in the first 6 weeks after implantation:*** until complete fixation of the leads

Issues Regarding Leads Selection

- ***Use of bipolar leads:*** in order to reduce the risk of myopotential inhibition during exertion

- ***Use of active screw-in fixation leads and single coil ICD leads:*** in order to reduce the risk of leads dislocation and to facilitate leads extraction

- ***Use of durable leads:*** in order to reduce the risk of lead failure

Issues Regarding Device Selection

- ***Use of small size devices:*** in order to reduce the hindrance to arm movements
- ***Use of single chamber devices:*** in order to reduce the risk of complications and system malfunction (?)
- ***Use of high energy ICDs:*** in order to reduce the risk of shock failure during exercise

Issues Regarding ICD Programming (1)

Table 2 Strategies for reducing inappropriate or unnecessary ICD-shocks.

Parameter	Use	Reducing Inappropriate or unnecessary shocks
Detection rate interval	Programming rate interval for VT discrimination	Both inappropriate and unnecessary shocks
Duration criterion	Differentiates non-sustained from sustained VT	Both inappropriate and unnecessary shocks
Sudden onset	Differentiates sinus tachycardia from VT	Inappropriate shocks
Stability criterion	Differentiates atrial fibrillation from VT	Inappropriate shocks
Morphology discrimination	Compares EGM-morphology in sinus rhythm to EGM-morphology during tachycardia	Inappropriate shocks
Lead noise algorithms	Differentiates lead noise from VT	Inappropriate shocks
T-wave oversensing algorithms	Reduces inappropriate detections of VT/VF in spontaneous T-wave oversensing episodes	Inappropriate shocks
Anti-tachycardia pacing	Refers to the use of pacing stimulation techniques for termination of tachyarrhythmias	Unnecessary shocks

Issues Regarding ICD Programming (2)

- ***Pivotal role of Exercise test and Holter for ICD programming***
- ***Recommended training intensity:*** maximal HR at least 10 bpm below ICD intervention zone
- ***Use of beta-blockers*** should be considered

Regular follow-up

- ***Searching for disease progression and symptoms***
- ***Teaching pts to monitor their HR during exercise***
- ***Device interrogation:*** for functioning evaluation and stored diagnostic data collection (rate histograms, % of pacing/sensing, pt's activity, tachyarrhythmias, ICD interventions)

Remote monitoring could help us to better follow PA pts/athletes with implanted devices

ILR
Reveal XT™

Attivatore esterno

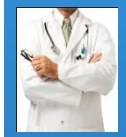
Programmatore

Paziente

Trasme
ttitore

Monitoraggio remoto CareLink

software web-based



Medico

Monitor cardiaco
impiantabile
Confirm™

Attivatore esterno

Programmatore

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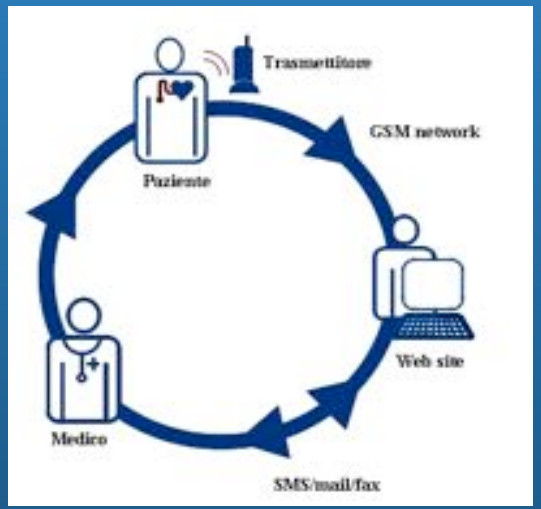
Medico



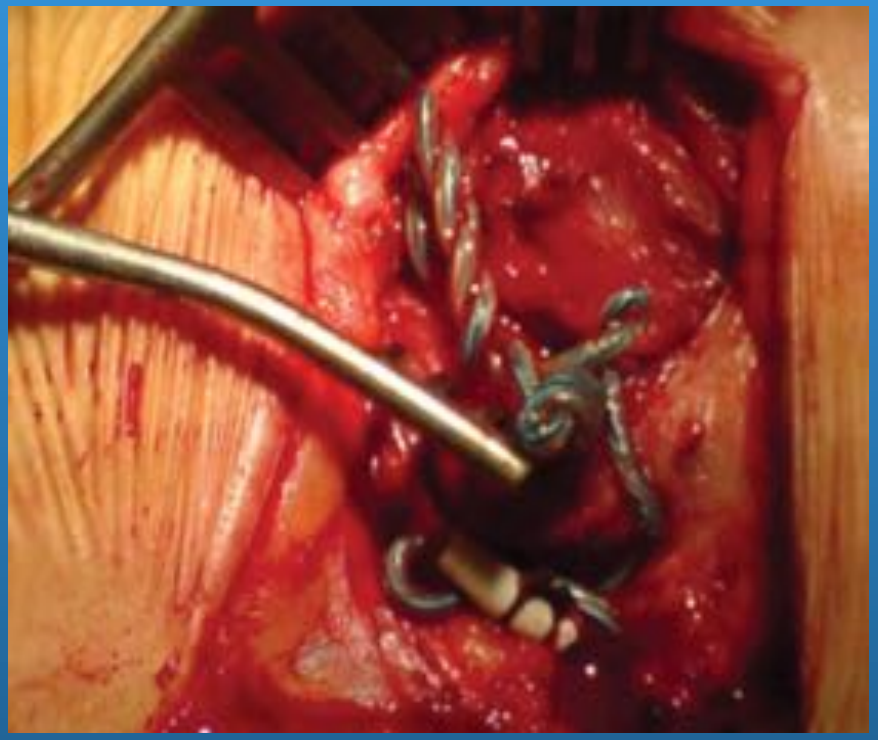
S-ICD: is it the real solution (at least in athletes without severe SHD) ?

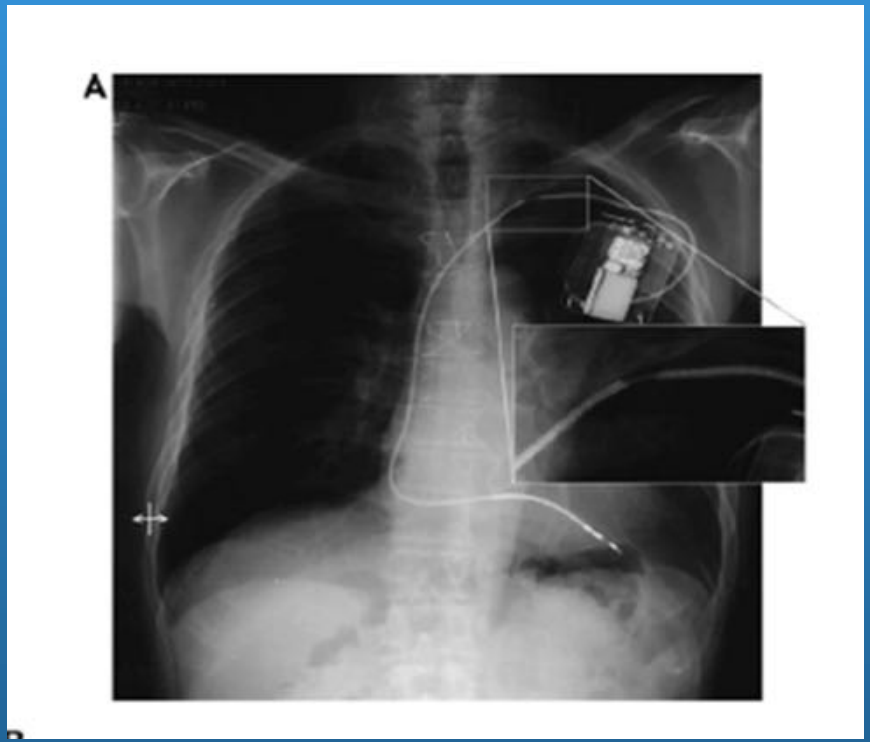
S-ICD: possible advantages vs TV-ICDs (1)

- Lower risk of direct trauma to the device and skin erosions ?

S-ICD: possible advantages vs TV-ICDs (2)

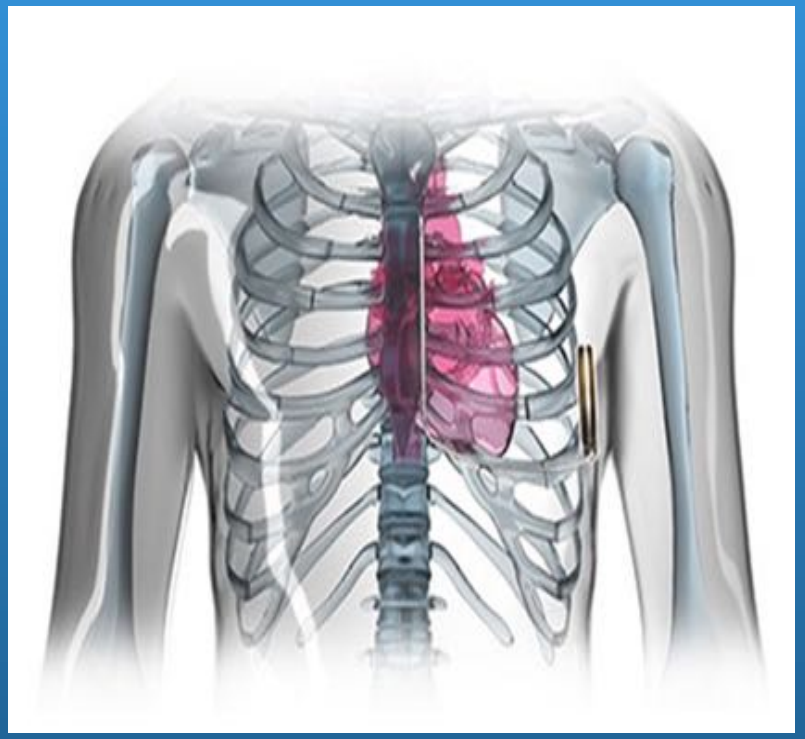
- Lower risk of leads' damage and dislocation secondary to repetitive superior arm movements ?





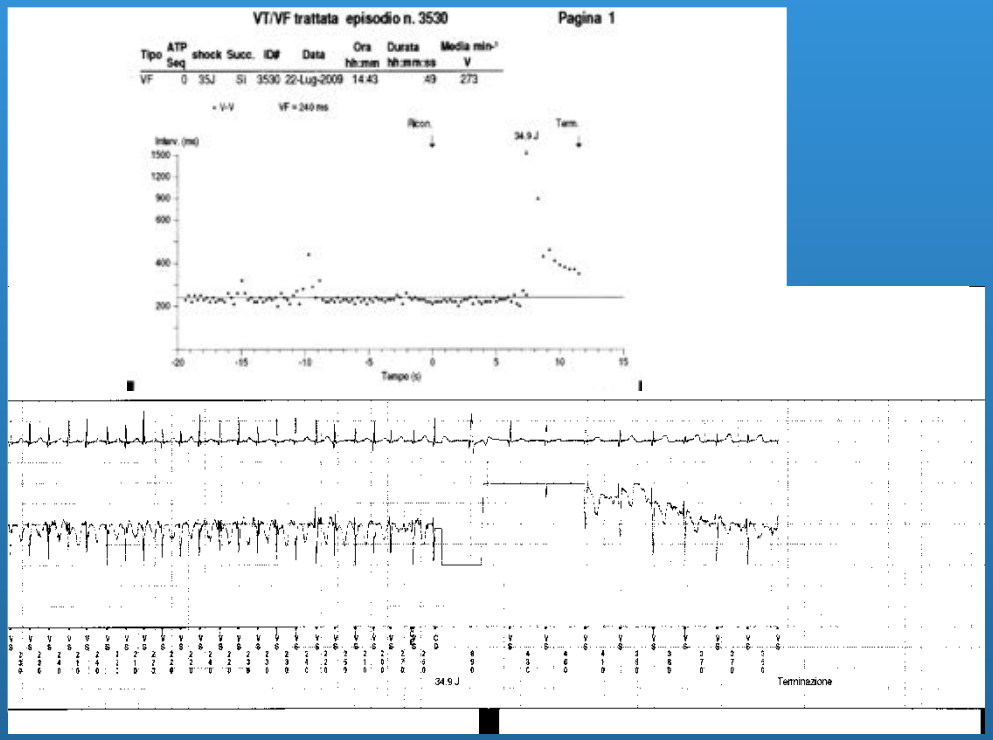
S-ICD: possible advantages vs TV-ICDs (3)

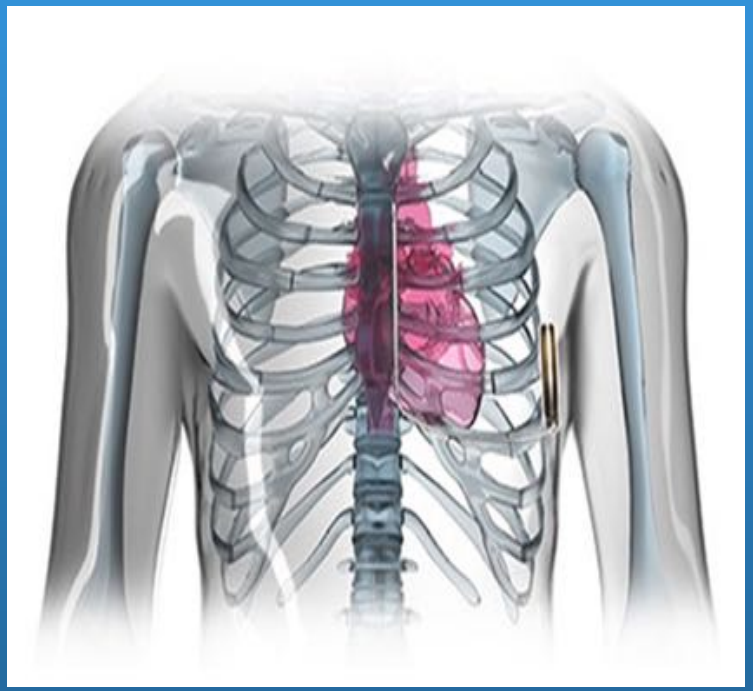
- Lower hindrance to superior arm movements ?



S-ICD: possible advantages vs TV-ICDs (4)

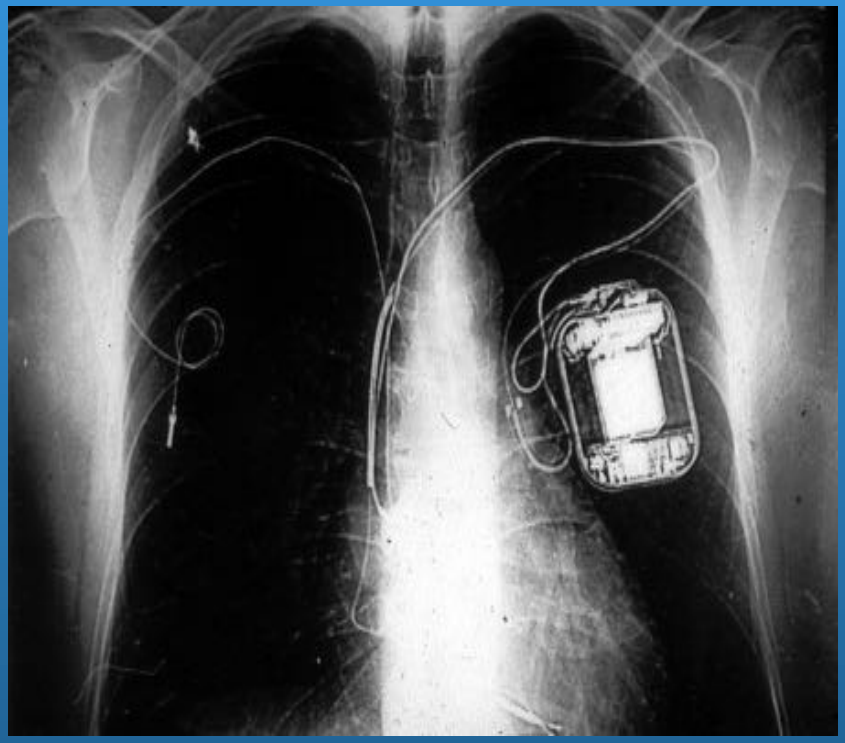
- Lower incidence of inappropriate shocks because of subcutaneous sensing ?





S-ICD: possible advantages vs TV-ICDs (5)

- Lower risk related to system revision in case of lead damage !



PA patients/athletes with ICDs
Conclusions (1)

- *Current guidelines are quite old, extremely prudent and based only on experts' opinion (evidence C)*
- *Sports-related risks in ICD recipiens seem overextimated; the major risk is an increase in both appropriate as well as inappropriate shocks*
- *Recent data support a revision of guidelines, at least in subjects without severe structural heart diseases, with a individual evaluation of risk to benefit ratio of training*

PA patients/athletes with ICDs
Conclusions (2)

- *S-ICDs could offer some advantages over TV-ICDs (we need confirmation of this hypotesis)*
- *ICD should not be viewed as a protective device that allow unlimited sports participation*
- *Physicians should have informed discussion of the risks and benefits of a particular sport with patient and family, and should make the decision togheter*
- *Physicians must remember their ethical purpose to protect the athlete's life*

Thanks for your kind attention !