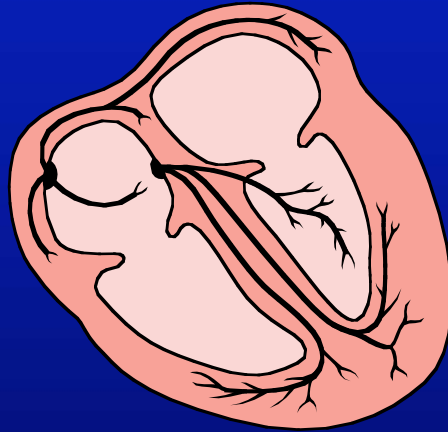


# COMMOTIO CORDIS



“Risk Management Forum for  
Amateur Sports”

**Bollinger Sports Forum**

November 15, 2006

VITO A. PERRIELLO, Jr. MD

# SUDDEN CARDIAC ARREST

350,000 DEATHS IN USA PER YEAR  
(More than all forms of cancer combined)

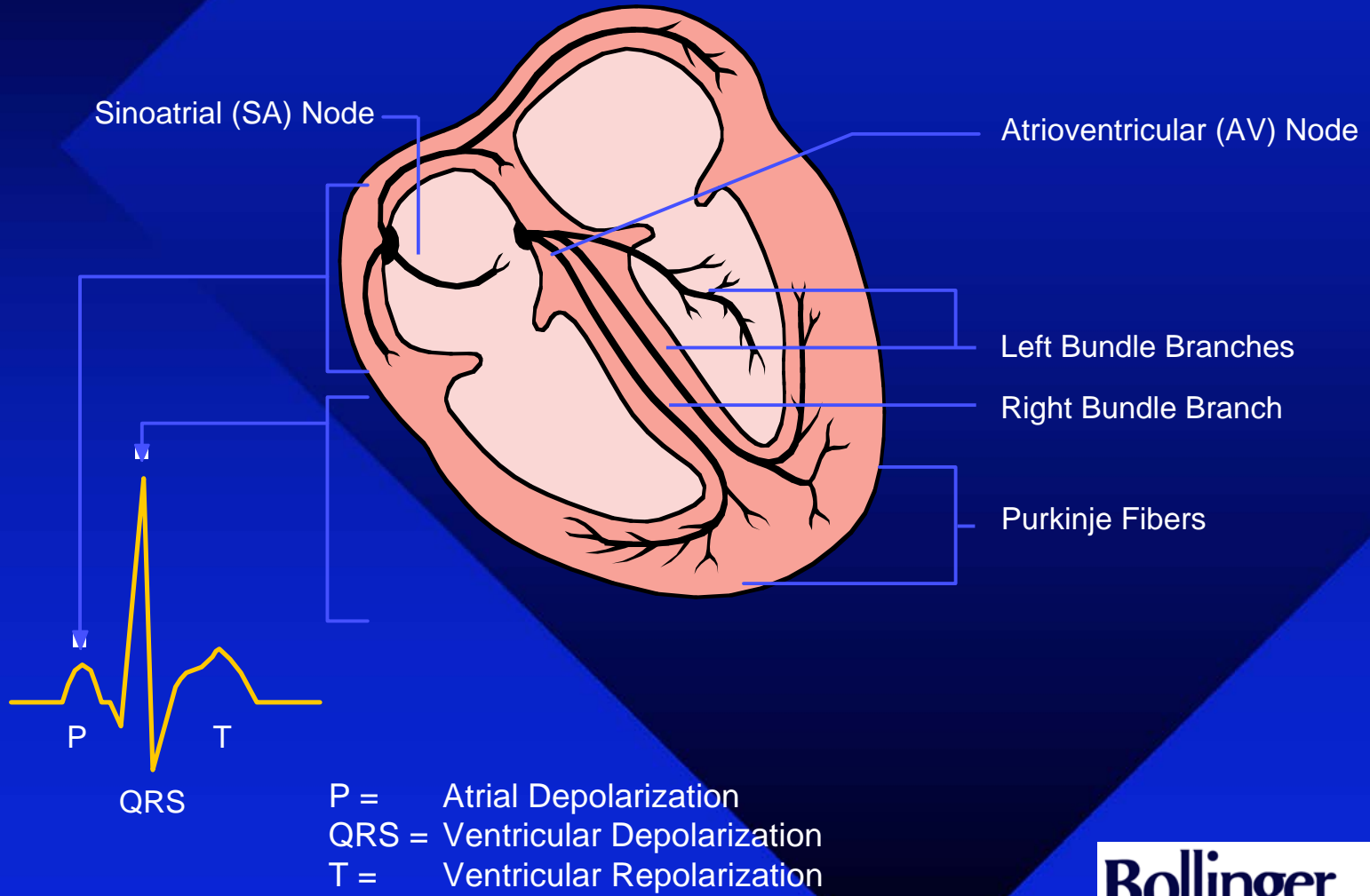
- Electrical system in the heart malfunctions
- Heart unexpectedly and abruptly stops beating
- Usually caused by an abnormal heart rhythm called ventricular fibrillation
- Not the same as a heart attack
- Can affect healthy individuals of all ages

# SUDDEN CARDIAC ARREST

- MOST COMMON CAUSES OF SCA
  - **Hypertrophic Cardiomyopathy**
  - Anomalous Coronary Artery
  - Prolonged QT Interval
  - Other Arrhythmias
  - Myocarditis
  - Mitral Valve Prolapse
  - **COMMOTIO CORDIS**



# Normal Conduction Pathway in the Heart and the ECG



# COMMOTIO CORDIS

- Relatively rare cause of cardiac arrest
- Occurs in individuals with no heart abnormality
- Caused by a blunt, non-penetrating injury to the chest
- Usually from projectile (ball or puck) but can be from other activities of daily living

# STATISTICS ON COMMOTIO CORDIS

- 128 – 152 Cases reported (low)
- Mean age 13.6yrs 72% < 18 years of age
- 95% male, 87% white, 16% survived
- 2/3rds sports related
- 68% from thrown projectile, 22% blow to chest with kick, helmet, etc
- 28% were wearing appropriate chest protection
- 2 were using ball designed to reduce risk
- 16% Survival Rate (25% < 3mins & 2.6% > 3 mins)

JAMA 287:3080, June 19, 2002 author reply Maron, Lin, et al.

AMERICAN HEART ASSOCIATION

*News Release 11.13.06A*

**Chest gear may not protect young athletes  
from deadly blows**

- 182 Cases since 1995
- 85 (47%) occurred in organized sports
- 33 (39%) fatal blow despite “protective equipment”
  - 23/33 projectile missed the chest protector
  - 10/33 hit directly
- Average 15 yrs.
- Sports:
  - Hockey 14 (2 goalies)
  - Football 10
  - Lacrosse 6 (3 goalies)
  - Baseball 3 (all catchers)

Barry Maron, Nov 13, 2006 AHA Meeting Chicago

# ACTIVITY INCIDENCE OF COMMOTIO CORDIS

**Table.** Characteristics of Chest Blows in 128 Commotio Cordis Events

Implements/Circumstances	No. of Events
Sports equipment	
Baseballs*	53
Softballs	14
Hockey pucks	10
Lacrosse balls	5
Cricket balls	2
Soccer ball	1
Hockey stick	1
Tennis ball (filled with coins)†	1
Bodily collisions in sports‡	
Knee or foot	5
Elbow or forearm	5
Shoulder	4
Fist§	2
Head (football helmet)	2
Goalpost	1
Daily and recreational activities	
Playful ("shadow") boxing	6
Parent-to-child discipline	5
Gang rituals	3
Scuffle	1
Plastic sledding saucer (diameter, 91.44 cm [36 in])	1
Plastic (hollow) toy bat	1
Snowball	1
Playground swing carriage	1
Pet (collie) dog head	1
Hiccups remedy (by friend)	1
Fall on playground apparatus ("monkey bars")	1

\*Includes 4 T-balls.

†Training device for baseball pitchers.

‡Baseball, football, karate, soccer, basketball, and hockey.

§Closed or open fist (including jab, push, slap).

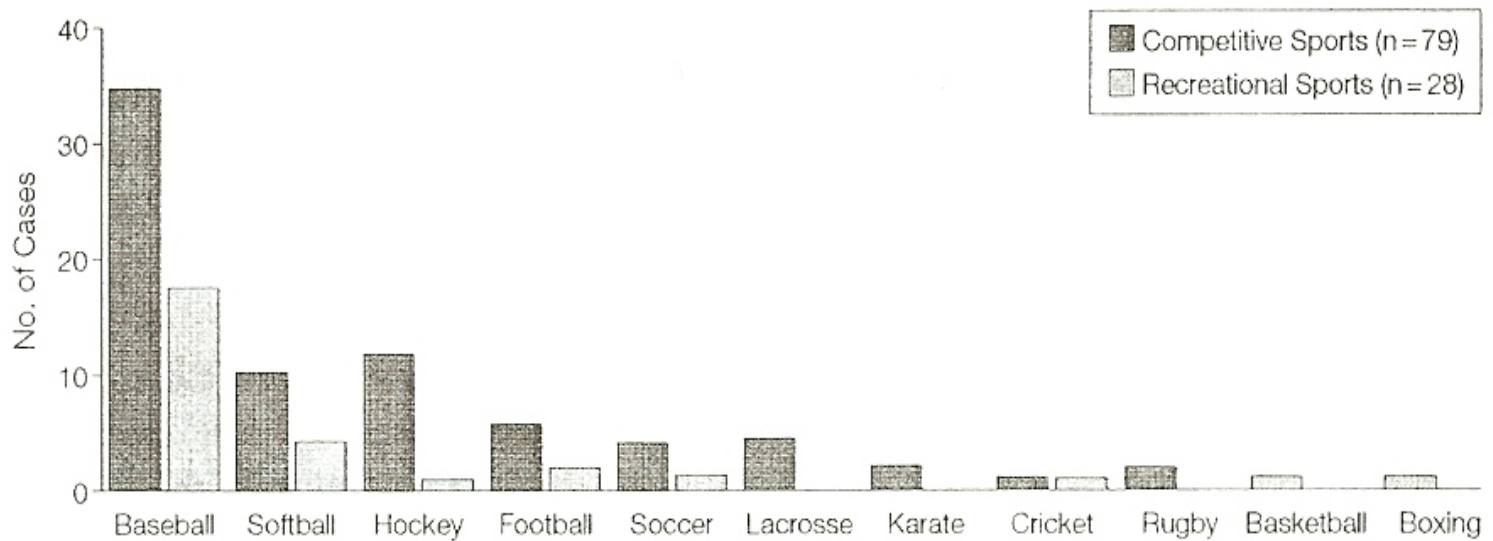


Maron, Link, et al Clinical Profile and Spectrum of Commotio Cordis

JAMA 287:1142-1146 March 6, 2002

## ACTIVITIES ASSOCIATED WITH COMMOTIO CORDIS

**Figure 2.** Sports Participated in at the Time of Commotio Cordis Events



Data are shown separately for competitive and organized recreational athletic activities. Four T-ball-related events are included in the baseball category.

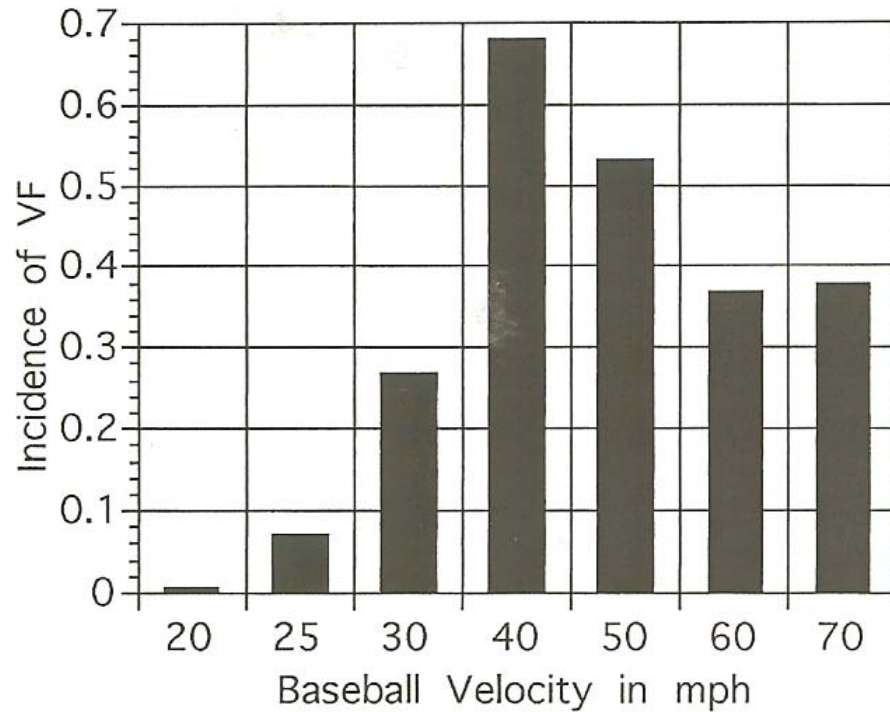
# MECHANISM OF ACTION

“Wrong force to wrong place at wrong time!”

Blow that creates Ventricular Fibrillation requires specific synchronization of multiple factors

1. Energy of Impact – Speed and hardness of object
2. Timing – 10-30msec before peak of T Wave
3. Location of blow – over left ventricle of heart
4. Age & Gender ( male and youth)
5. Other unknowns

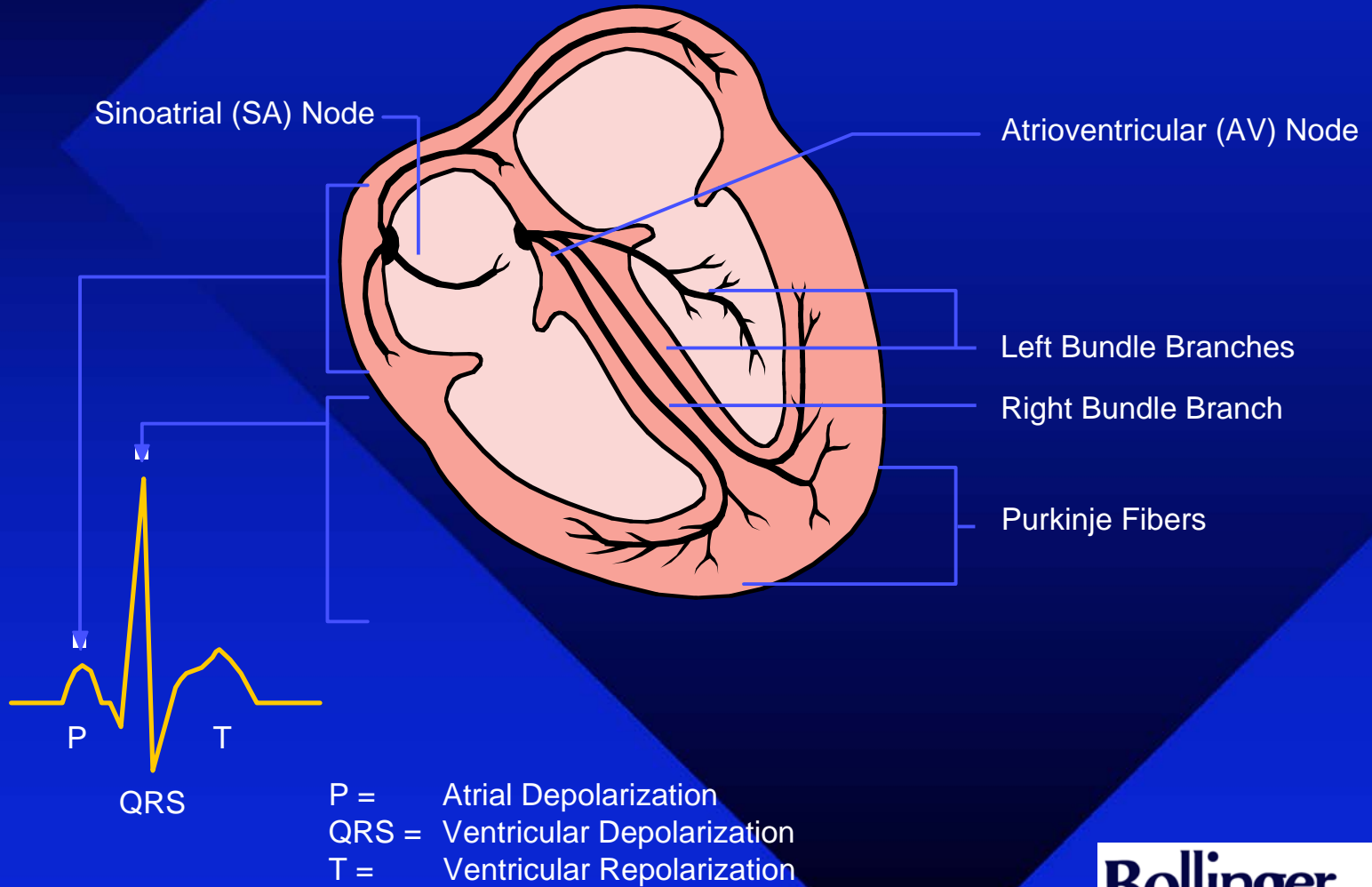
# ENERGY OF IMPACT



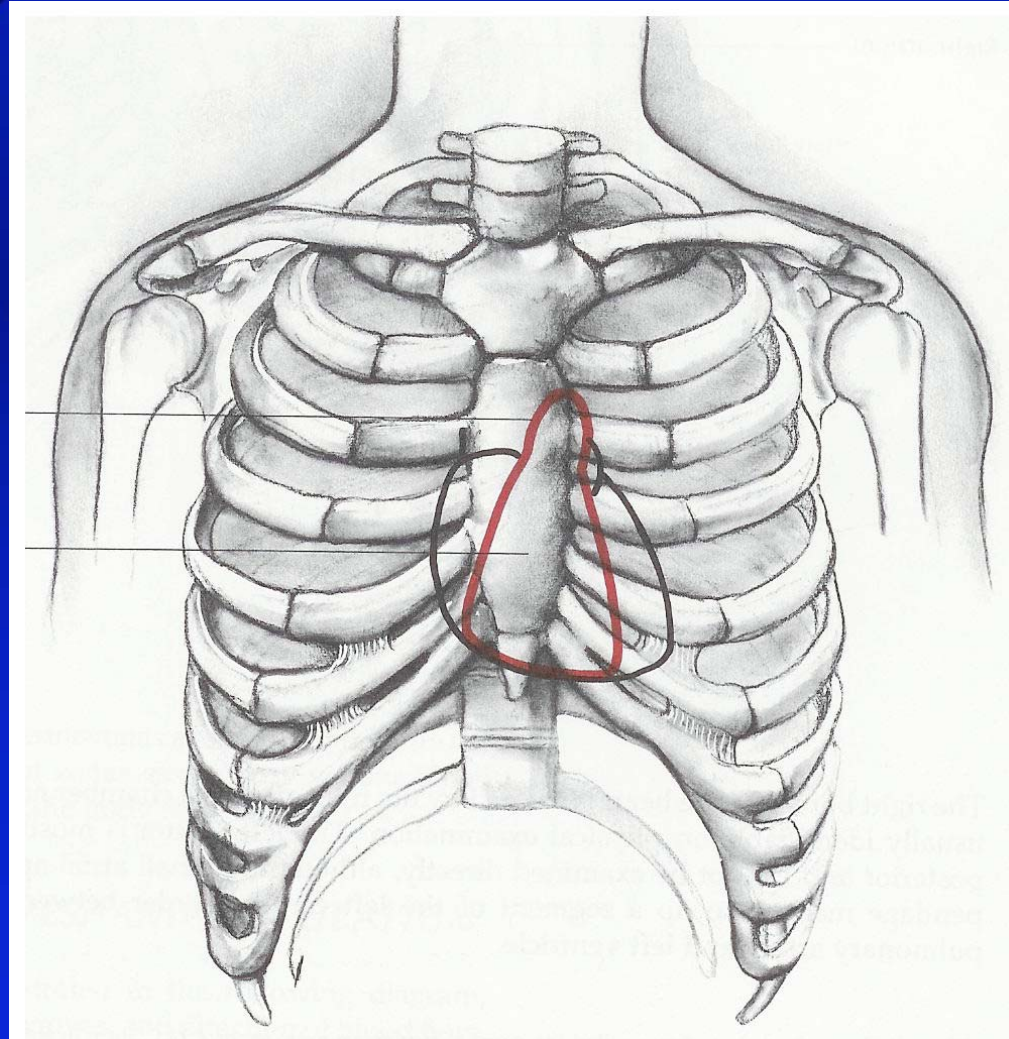
**Figure 1.** Incidence of ventricular fibrillation (VF) induced by chest-wall impact at the vulnerable period of repolarization, with a regulation baseball propelled at a range of velocities under controlled conditions (logistic regression model  $p < 0.0001$  predicting VF from mph and  $\text{mph}^2$ ).

- Link et al, Upper and Lower Limits of Vulnerability...
- ,Journal of American College of Cardiology41:99-104, MJan 1, 2003

# TIMING OF THE CARDIAC CYCLE

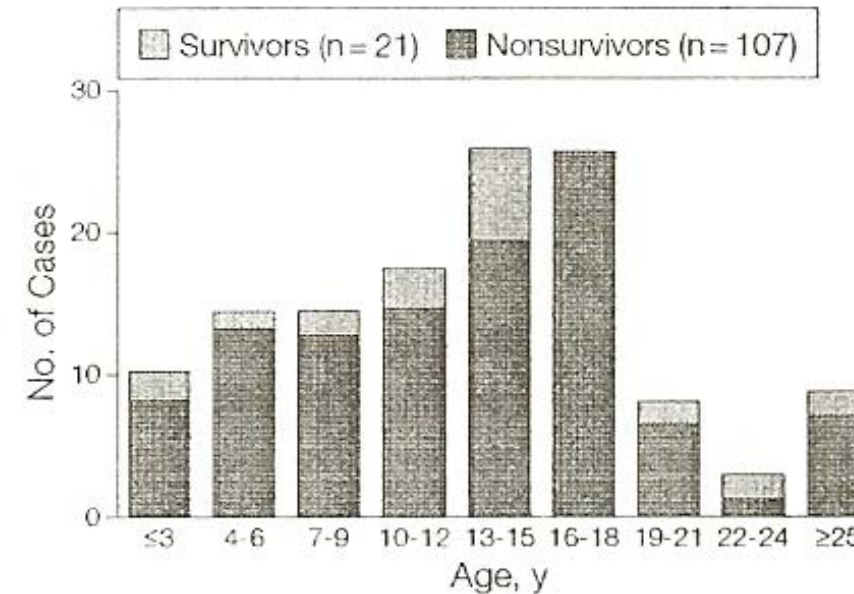


# LOCATION OF BLOW



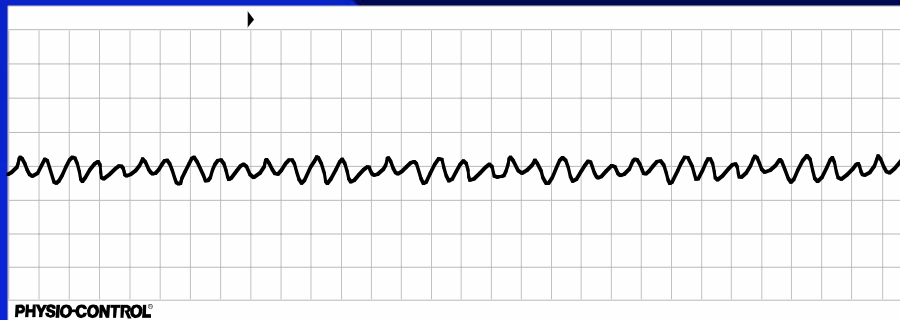
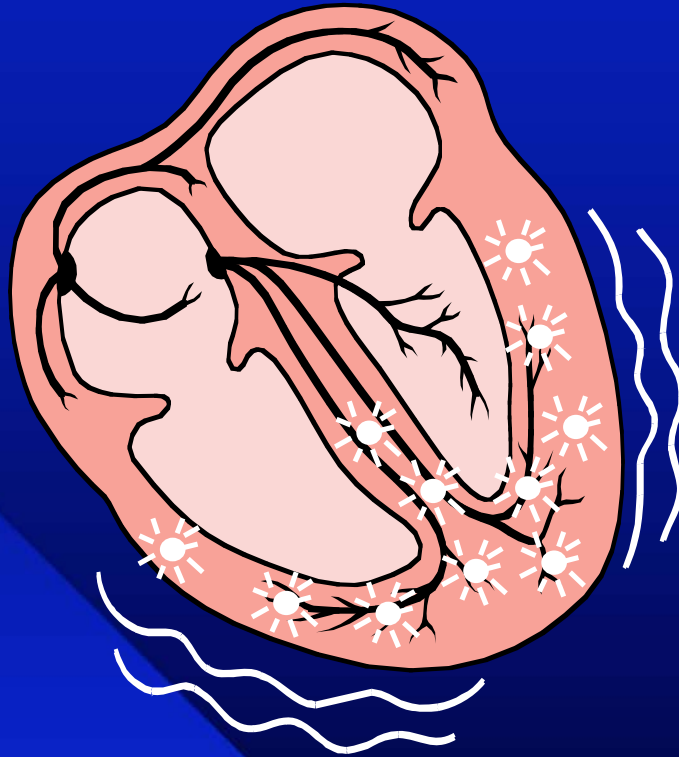
# AGE INCIDENCE OF COMMOTIO CORDIS

**Figure 1.** Age at Time of Commotio Cordis Event



Maron, Link, et al Clinical Profile and Spectrum of Commotio Cordis  
 JAMA 287:1142-1146 March 6, 2002

# Ventricular Fibrillation



PHYSIO-CONTROL®

## REACTIONS BY DIFFERENT GROUPS

1. Recommend all players wear chest protectors
2. Develop standard for new chest protector
3. Require AED's everywhere sports are played
4. Study existing research and commission more research
5. Rule Changes for defense
6. Ignore

# WHAT WE DON'T KNOW

- Why at faster speeds VF is less common
  - Spasm of coronary artery
  - Aberration of K<sup>+</sup> pump channel
  - Change in autonomic nervous system
- Is chest protector positive or negative
- Does soft ball protect or not
- Why EKG's abnormal for few days
- Why autopsies and muscle enzymes normal after blow
- WHAT IS PERFECT MATCH OF SPEED, HARDNESS OR BALL, THICKNESS AND MATERIAL OF CHEST PROTECTOR

## WHAT WE DO KNOW

- Prevention is best treatment
- Quick recognition and action is critical
- Best treatment for an arrhythmia is defibrillation, like with an AED. CPR alone will rarely work
- Animal studies show at 1 minute 100% success, at 2 minutes 80% and at > 4 minutes 0% survive
- Present chest protectors don't work

# NCAA AED EXPERIENCE

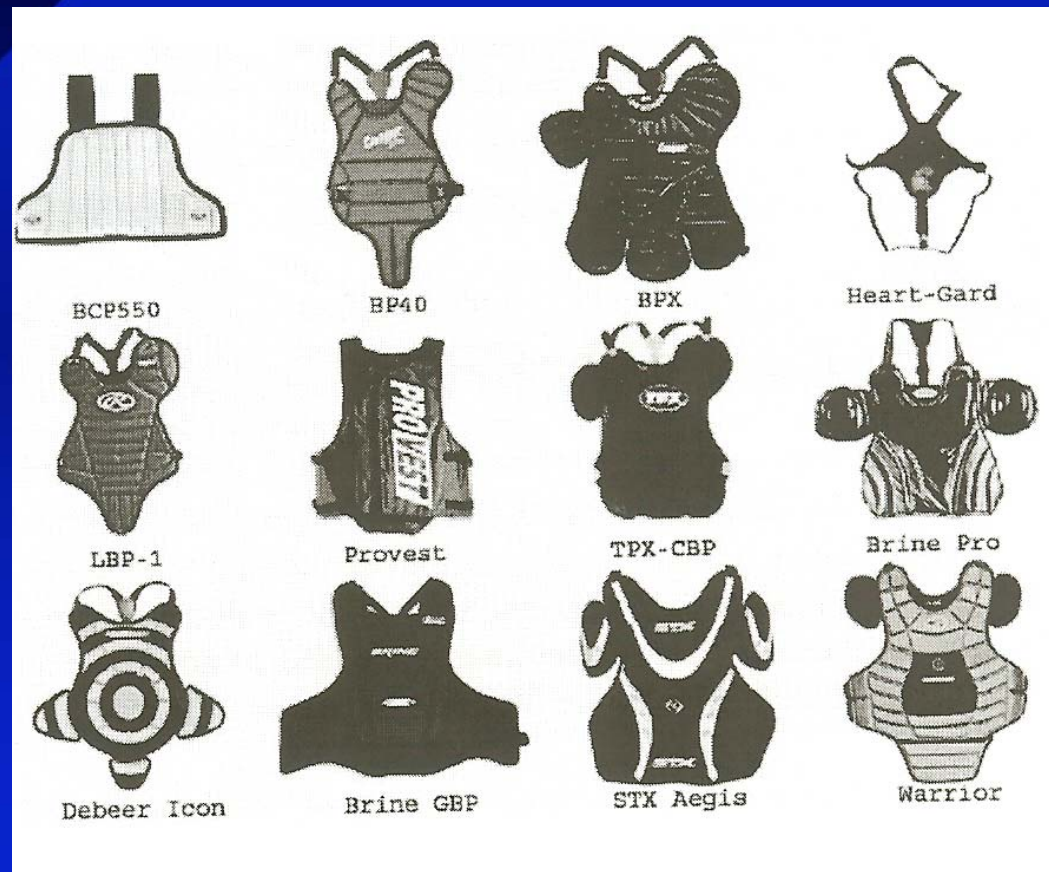
- 16 Institutions
  - 20% of use on Students
  - 33% used on Athletic Department staff
  - 47% use was on fans
- 3.4 min average time to shock
- 8.2 mins EMS response time
- Survival
  - 0% students
  - 75% Staff
  - 57% fans
  - 61% overall

Coris, et al Sudden Cardiac Death in Division I Collegiate Athletics,  
Clin J Sport Med 15:87-94, March 2005

# RECOMMENDATIONS

- Have an Emergency Plan available for all levels of participation to include cardiac chain of survival
- Encourage and Facilitate education and training of athletic community at all levels
- Have AED's readily available wherever feasible
- Collect and analyze injury data to determine if changes in rules and/or equipment can provide an opportunity to reduce risk from SCA
- Consider use of a softer baseball and lacrosse ball
- Continue supporting and studying research on pathophysiology and the development of new chest protectors

# THANK YOU



Weinstock, Maron, et al Failure of Commercially Available Chest Wall Protectors,  
Peds117:21-210, March 7, 2006