EMB IEEE Hong Kong Chapter

HONG KONG SPORTS INSTITUTE 香港體育學院

香港中文大學 The Chinese University of Hong Kong

20 YEARS OF EXCELLENCE 卓越二十年 CUHK ENGINEERING

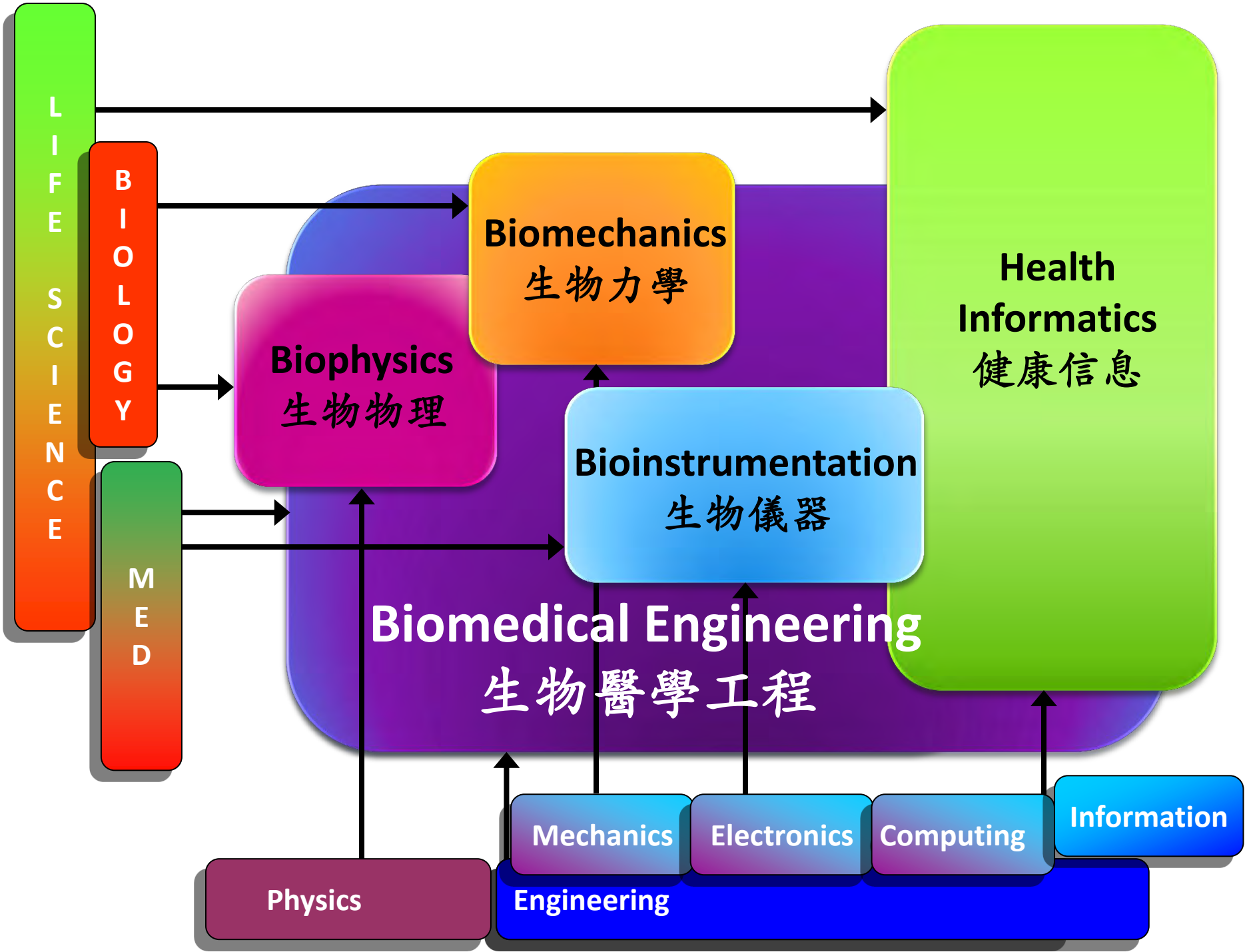
Biomedical Engineering in Sports Science

Carmen C. Y. Poon

Joint Research Centre for Biomedical Engineering

Dept. of Electronic Engineering, The Chinese University of Hong Kong

Hong Kong Sports Institute, 3rd June 2011


LIFE SCIENCE
BIOLOGY
MED
Biomechanics
生物力學
Biophysics
生物物理
Bioinstrumentation
生物儀器
Biomedical Engineering
生物醫學工程
Health
Informatics
健康信息
Physics
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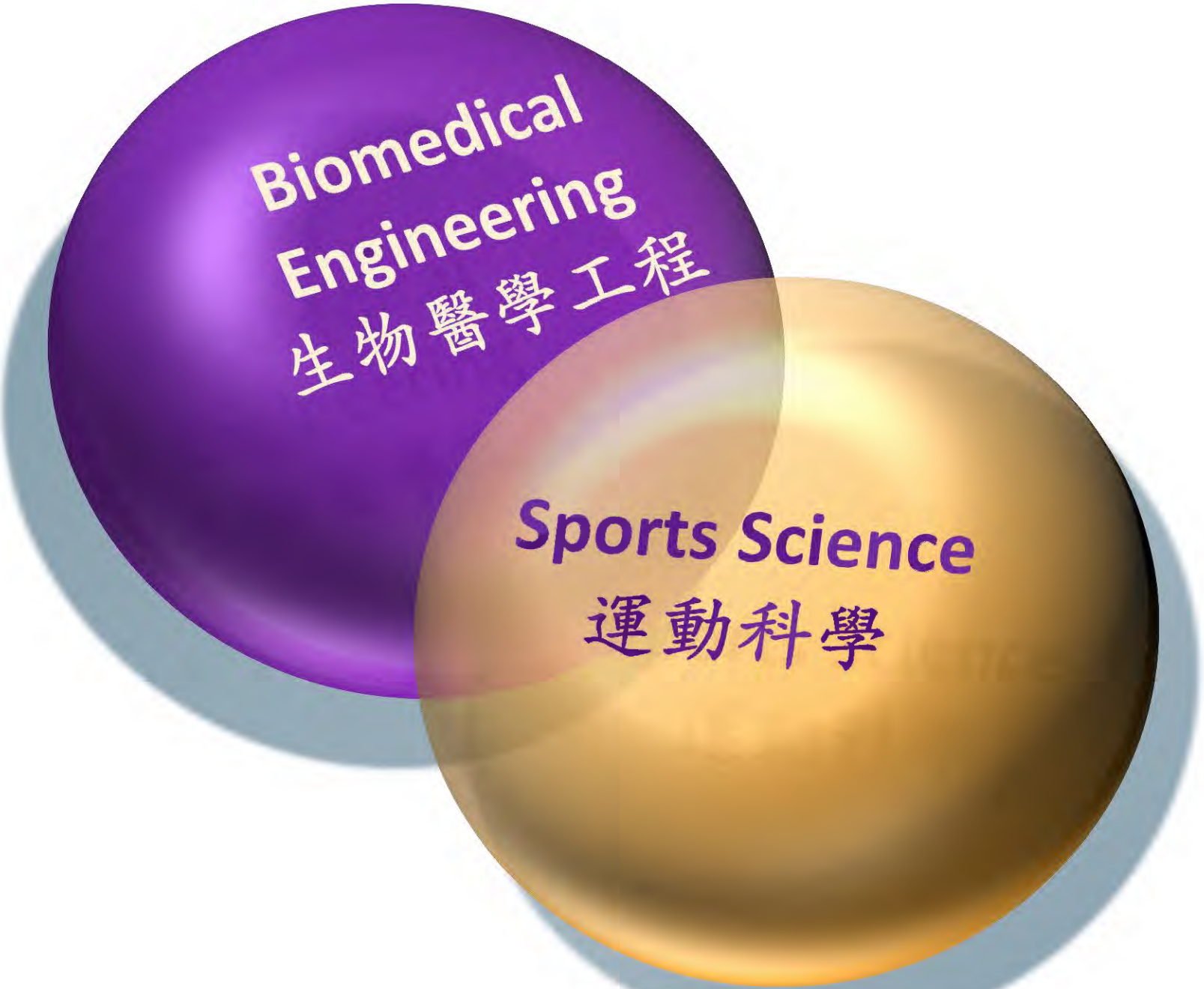
Computing
Information

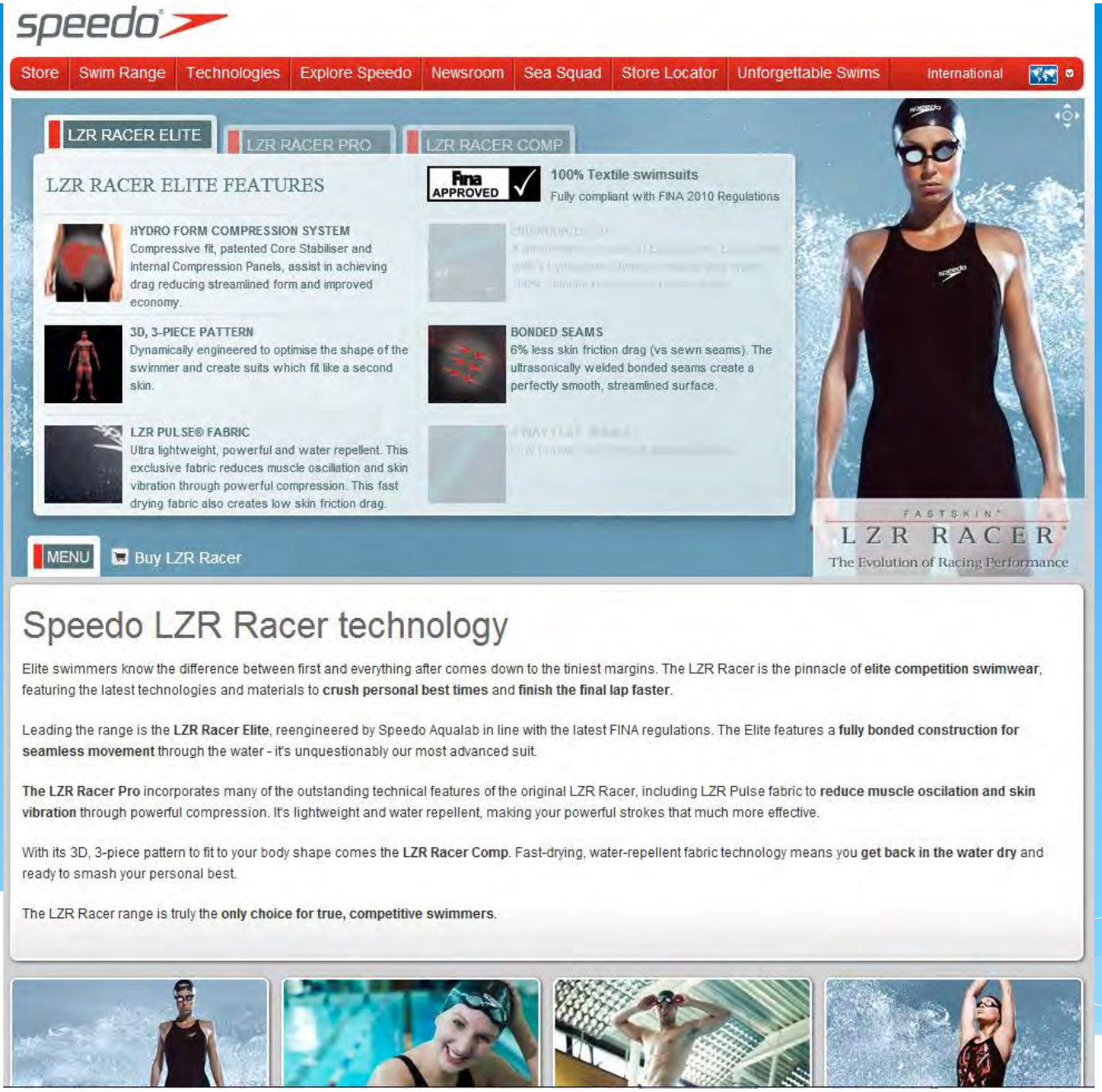

Biomedical
Engineering
生物醫學工程
Sports Science
運動科學

Goals

* To Improve Performance
  1. Acquisition (medical devices)
  2. Information Management (e-records)
  3. Analysis (modelling, data mining)
  4. Feedback, Correction

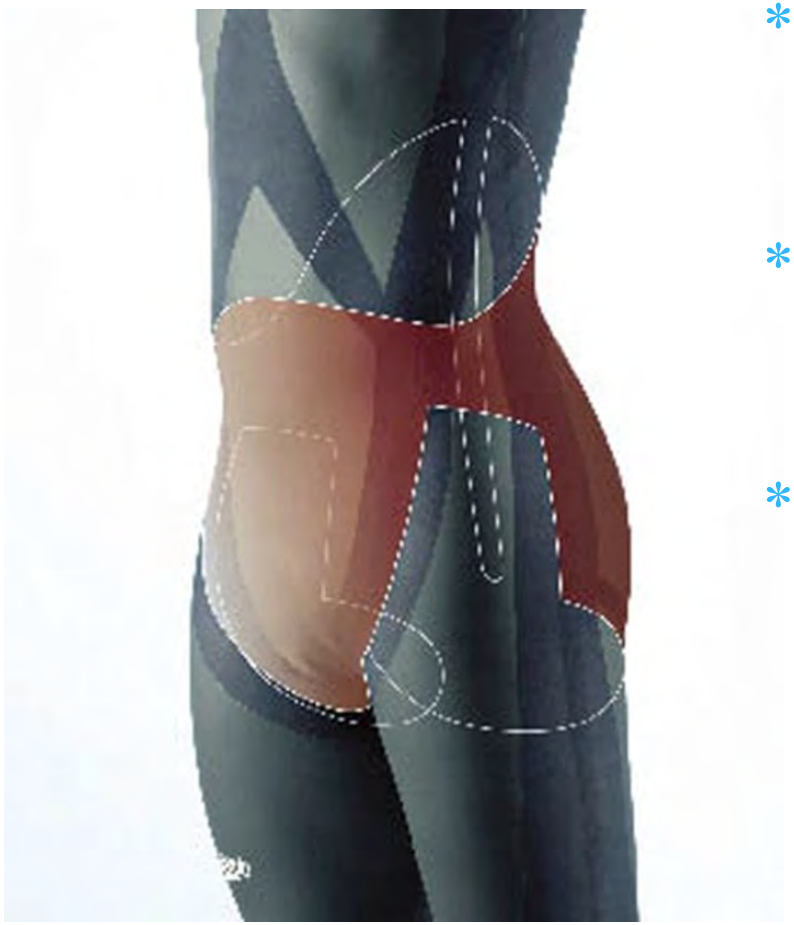
* To Ensure Health (vs. medicine)
  - Preventive

Wearable Intelligent Systems



www.speedo.com

The LZR Racer



* Provides extra compression in key areas to help a swimmer use less energy to swim more quickly.
* Reduces skin friction drag by covering more skin than traditional swimsuits.
* Multiple pieces of the water-resistant and extremely lightweight LZR Pulse™ fabric connect at ultrasonically welded seams and incorporate extremely low-profile zippers to keep viscous drag to a minimum.

www.speedo.com

Wearable Intelligent System

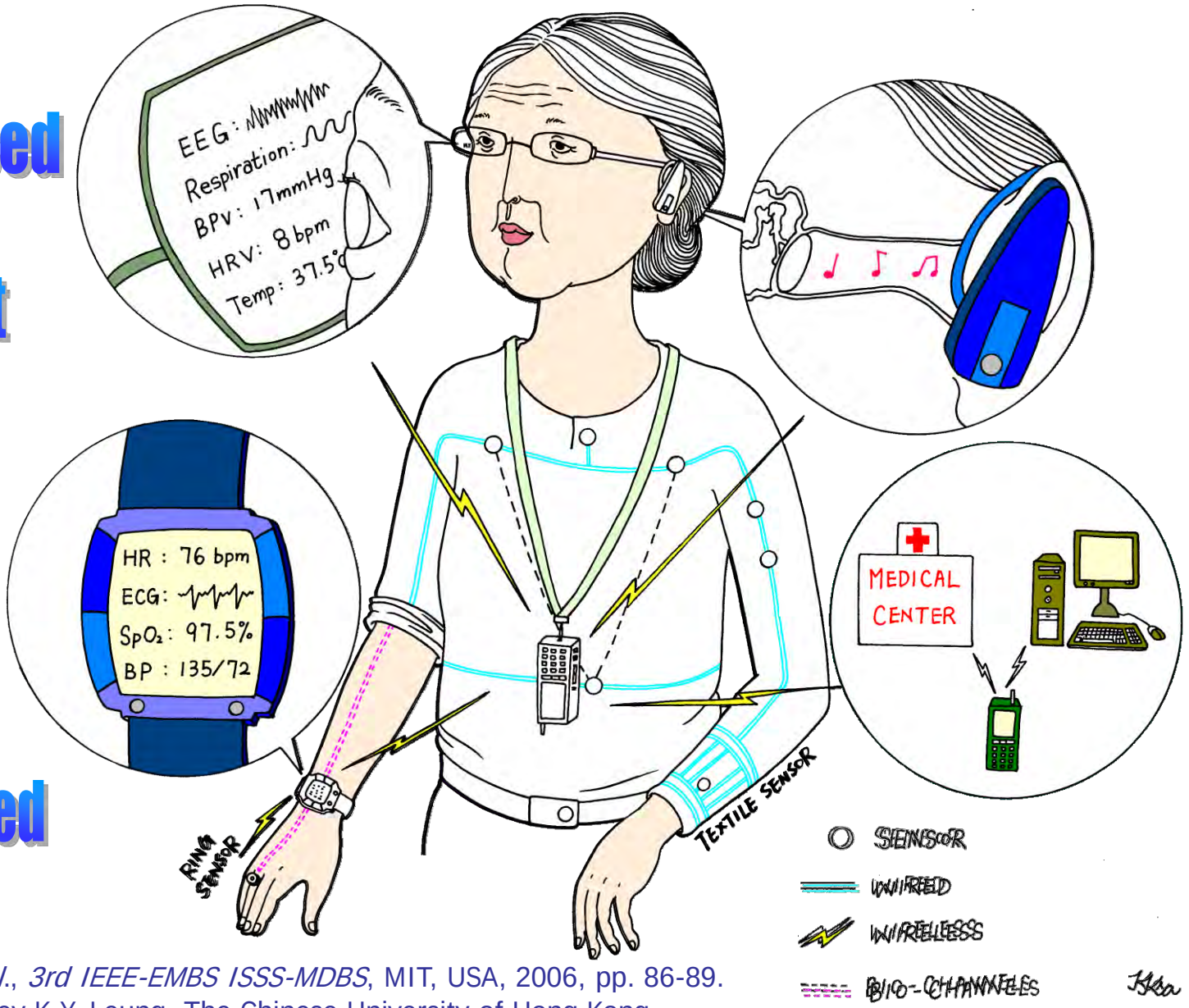
Miniaturised

Intelligent

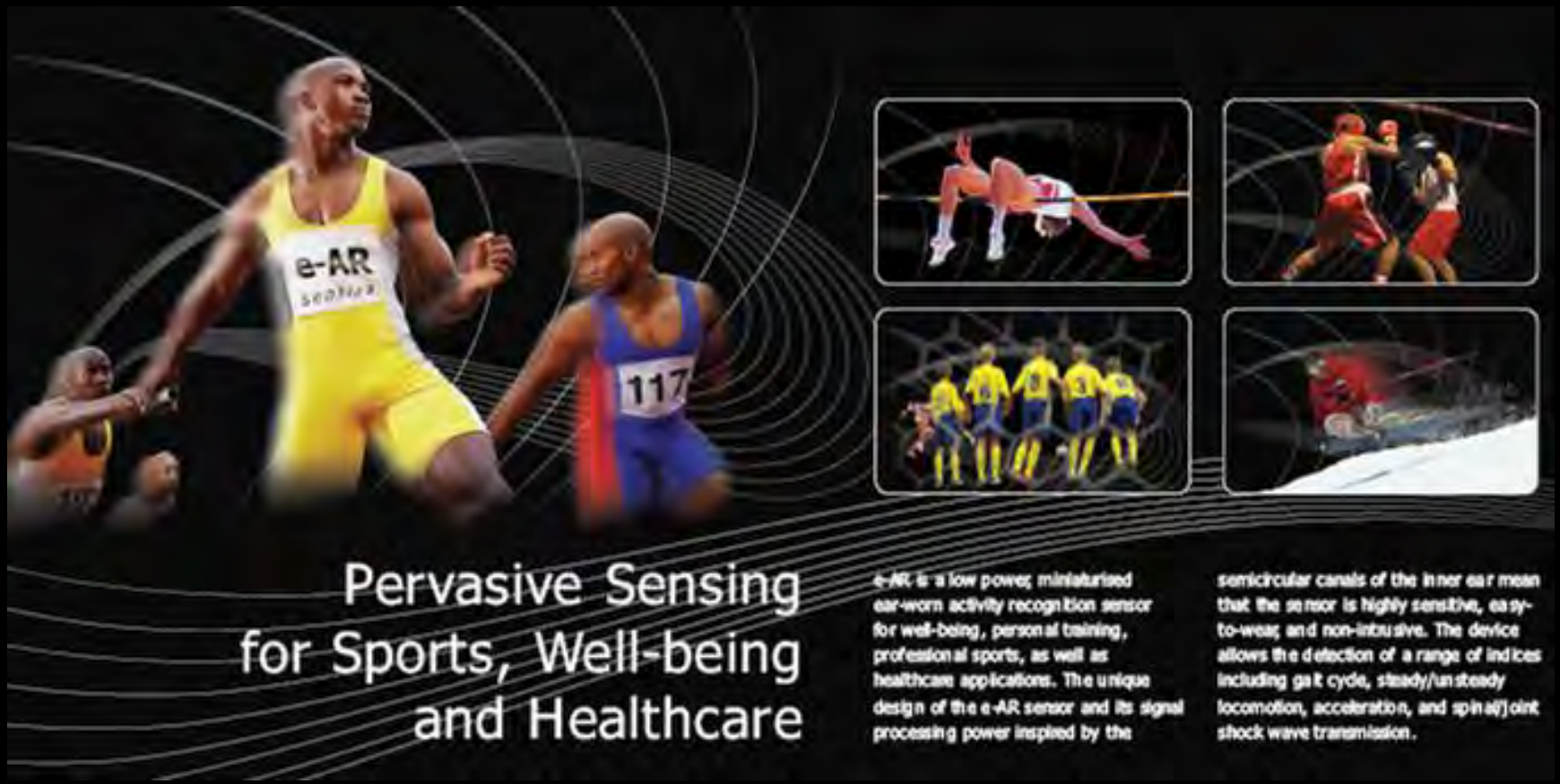
Networked

Digitalised

Standardised



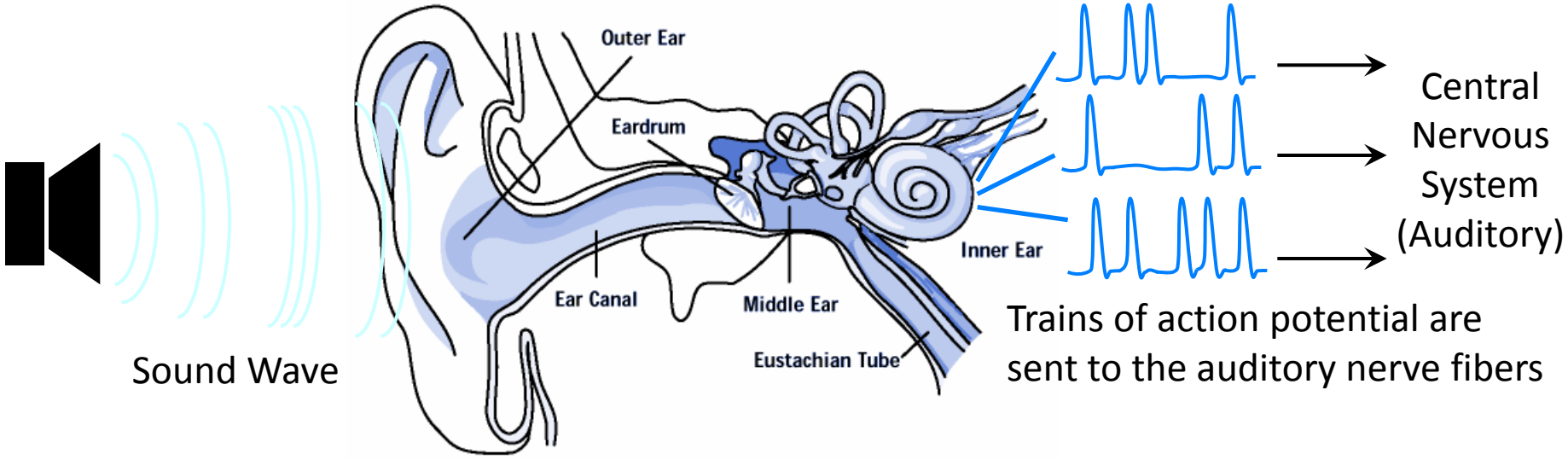
Y.T. Zhang, C.C.Y. Poon *et al.*, *3rd IEEE-EMBS ISSS-MDBS*, MIT, USA, 2006, pp. 86-89.
Artwork: Courtesy of Ms. Joey K.Y. Leung, The Chinese University of Hong Kong



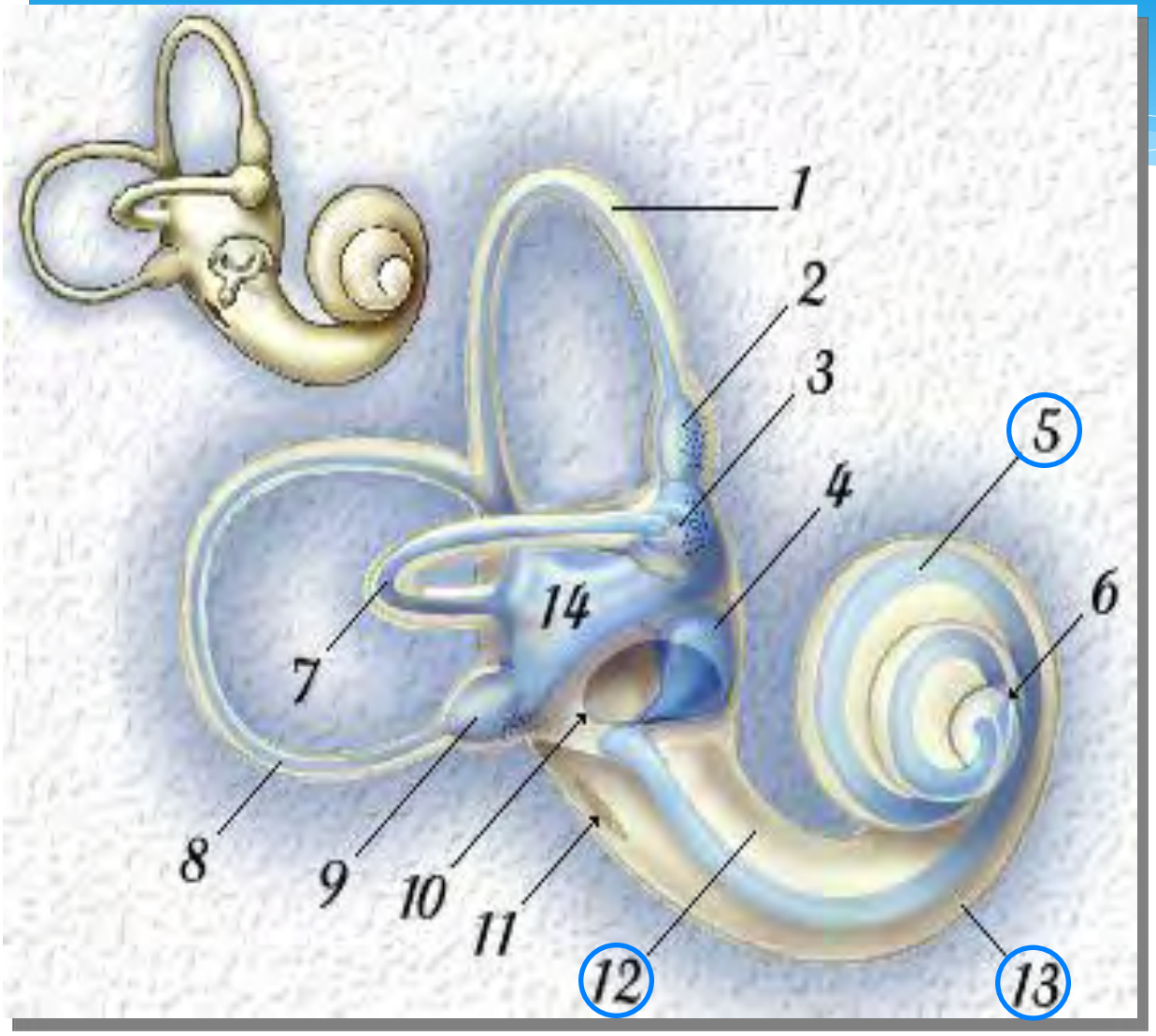
G. Z. Yang et al., Imperial College, www.sensixa.com

Physiology of Auditory System

* Mechanical signal is transformed into electrical signal at the cochlear.
  - The motion of **basilar membrane** (BM) changes with sound pressure.
  - The **inner hair cells** (IHC), paired to the BM segment, transmits this mechanical signal to chemical neurotransmitter's release, which gives rise to **auditory nerve** (AN) firing.



Mechano-Electro Transducing



1. Anterior 1/2 circular canal
2. Ampulla (anterior canal)
3. Ampulla (horizontal canal)
4. Sacculus
5. **Cochlear duct**
6. Helicotrema
7. Lateral (horizontal) canal
8. Posterior canal
9. Ampulla (posterior canal)
10. Oval window
11. Round window
12. **Vestibular duct (scala vestibuli)**
13. **Tympanic duct (scala tympani)**
14. Utriculus

Sensixa e-AR

* Bio-inspired design
* Real-time gait cycle, steady/unsteady locomotion, acceleration, and spinal/joint shock wave sensing
* Ultra low power processor with integrated 2.4 GHz RF

Videos
http://vip.doc.ic.ac.uk/benlo/m775.html

G. Z. Yang et al., Imperial College, www.sensixa.com

明報

12歲運動女將覆診後猝死 月前曾休克入院 醫生兩檢查指無礙

(明報)2011年5月21日 星期六 05:10

【明報專訊】12歲運動女將一個月前突然休克到屯門醫院 求醫，留院接受多項檢查，包括檢查心臟亦找不出原因，於是批准女童先出院。女童前日覆診時，院方醫生仍稱身體無恙，詎料女童回家後僅10多小時，昨晨猝死元朗寓所床上。女童雙親痛斥院方處事方法有問題：「明明說無事，為什麼會死？」

心臟科醫生何鴻光表示，一般猝死個案約70%至90%與心臟有關，10%至30%可能與腦部有關；中大內科（腦科）講座教授黃家星指出，病人失神、昏迷又蘇醒，檢查的標準做法是做心電圖、腦電圖和腦掃描等檢查找出病因（見另稿）。

Google

猝死 運動 搜尋

約有 143 項結果 (搜尋時間：0.17 秒)

Google.com in English 進階搜尋

- 全部
- 圖片
- 影片
- 新聞
- 更多

焦點新聞

網路
所有中文網頁
繁體中文網頁
香港的網頁

所有新聞
圖片
網誌搜尋

不限時間
過去 1 小時
過去 24 小時
過去 1 週
過去 1 個月
自訂日期範圍...

依關聯性排序
按日期排序

12歲運動女將覆診後猝死

加拿大星島日報

香港新浪網 - 2011年5月20日

（梁琬珊攝） 仵工於博愛醫院，將於夢中猝死的12歲女童遺體舁走。（林錫禮攝） 【明報專訊】12歲運動女將一個月前突然休克到屯門醫院求醫，留院接受多項檢查，包括檢查 ...

12歲149磅 熱衷各類運動 孝順肥妹 夢中猝死 - 成報
香港·12歲運動女健將·通宵"煲"電視劇猝死 - 星洲日報
安慰失業父買蛋糕送母 - 新報
加拿大星島日報 - 香港商報-中國窗
共有 9 篇相關新聞 »

退休校長戰死足球場

成報

香港新浪網 - 2011年5月14日

(綜合報道)(星島日報報道)何文田昨晨發生踢波猝死意外，熱愛運動的新界喇沙書院退休校長周錫輝，參加由教育局舉辦的首屆四角足球賽，至下半場他在禁區迎頂一個角球後 ...

跳頂角球 倒地不起 新界喇沙前校長周錫輝踢波猝死 - 成報
新界喇沙前校長 踢波猝死球場 - 香港文匯報
退休校長周錫輝戰死足球場 - 香港商報
共有 19 篇相關新聞 »

運動猝死多關心臟問題

香港新浪網 - 2011年5月14日

【明報專訊】浸會大學體育學系副教授雷雄德表示，運動猝死與有否足夠熱身無關。他說，有運動習慣的人，運動猝死的風險較低，但不代表不會發生。據統計，每10萬至30萬人 ...

Circulation
Arrhythmia and Electrophysiology
Journal of the American Heart Association
American Heart Association
Learn and Live

Sudden Death in the Young
What Do We Know About It and How to Prevent?

Christian van der Werf, MD; Irene M. van Langen, MD, PhD; Arthur A.M. Wilde, MD, PhD

Table 2. Clinicopathological Series on SD ≤40 Years Published Between 1990 and Mid-2009

Study	Type of SD	Hours From Onset of Complaints	Study Period	Age, y	Study Population	n	Country
Burke[21]	SCD/SUD	<24	1981–1988	14–40	General	690	United States
Corrado[17]	SCD/NCSD/SUD	<1	1979–1999	12–35	General/athletes	245/51*	Italy
Doolan[19]	SCD/NCSD/SUD	<24	1994–2002	<35	General	425†	Australia
Drory[20]	SCD/NCSD/SUD	<24	1976–1985	9–39	General	162	Israel
Eckart[15]	SCD/NCSD/SUD	<1	1977–2001	17–35	Military	126	United States
Fabre[23]	SCD/SUD	ND	1994–2003	15–35	General	223	United Kingdom
Gioia[18]	SCD/NCSD/SUD	<6	2001–2005	1–40	General	155	Italy
Maron[13]	SCD/NCSD/SUD	ND	1985–2000	<35	Athletes	1041‡	United States
Morris[16]	SCD/NCSD/SUD	<1	2005	<35	General	62§	Ireland
De Noronha[27]	SCD/SUD	<12	1996–2008	≤ 35	Athletes	89	United Kingdom
Puranik[24]	SCD/NCSD/SUD	<24	1995–2004	5–35	General	427	Australia
Quigley[22]	SCD/SUD	<6	1993–2002	<35	General	72	Ireland
Shen[9]	SCD/NCSD/SUD	<1	1960–1989	20–40	General	54	United States
Steinberger[25]	SCD/SUD	<24	1967–1992	1–21	General	50	United States
Van Camp[28]	SCD/NCSD/SUD	<1	1983–1993	13–24	Athletes	105‖	United States
Wisten[26]	SCD/SUD	<1	1992–1999	15–35	General	181	Sweden
Wren[5]	SCD/NCSD/SUD	ND#	1985–1994	1–20	General	128	United Kingdom

We selected all clinicopathological studies including SD victims ages 1 to 40 years and published between 1990 and mid–2009. Only studies which extensively described the causes of SD/SCD were included, for example, a specified type of cardiomyopathy instead of "cardiomyopathy" as the final diagnosis. NCSD indicates noncardiac sudden death.

*No. of SCD/SUD cases in athletes, pulmonary thromboembolism (n=1) excluded.

†181 SD victims age <1 year excluded.

‡No. of SCD/SUD cases, sickle cell trait (n=5) and stroke (n=3) excluded.

§No. of SCD/SUD cases, 16 SD victims age <1 year excluded.

‖No. of SCD/SUD cases, ruptured cerebellar arteriovenous malformation (n=1) and subarachnoid hemorrhage (n=1) excluded.

#SD out of hospital, on arrival at hospital or in the emergency department.

Annals of Internal Medicine | ARTICLE

Cardiovascular Screening in College Athletes With and Without Electrocardiography

A Cross-sectional Study

Aaron L. Baggish, MD; Adolph M. Hutter Jr., MD; Francis Wang, MD; Kibar Yared, MD; Rory B. Weiner, MD; Eli Kupperman, BA; Michael H. Picard, MD; and Malissa J. Wood, MD

Background: Although cardiovascular screening is recommended for athletes before participating in sports, the role of 12-lead electrocardiography (ECG) remains uncertain. To date, no prospective data that compare screening with and without ECG have been available.

Objective: To compare the performance of preparticipation screening limited to medical history and physical examination with a strategy that integrates these with ECG.

Design: Cross-sectional comparison of screening strategies.

Setting: University Health Services, Harvard University, Cambridge, Massachusetts.

Participants: 510 collegiate athletes who received cardiovascular screening before athletic participation.

Measurements: Each participant had routine history and examination–

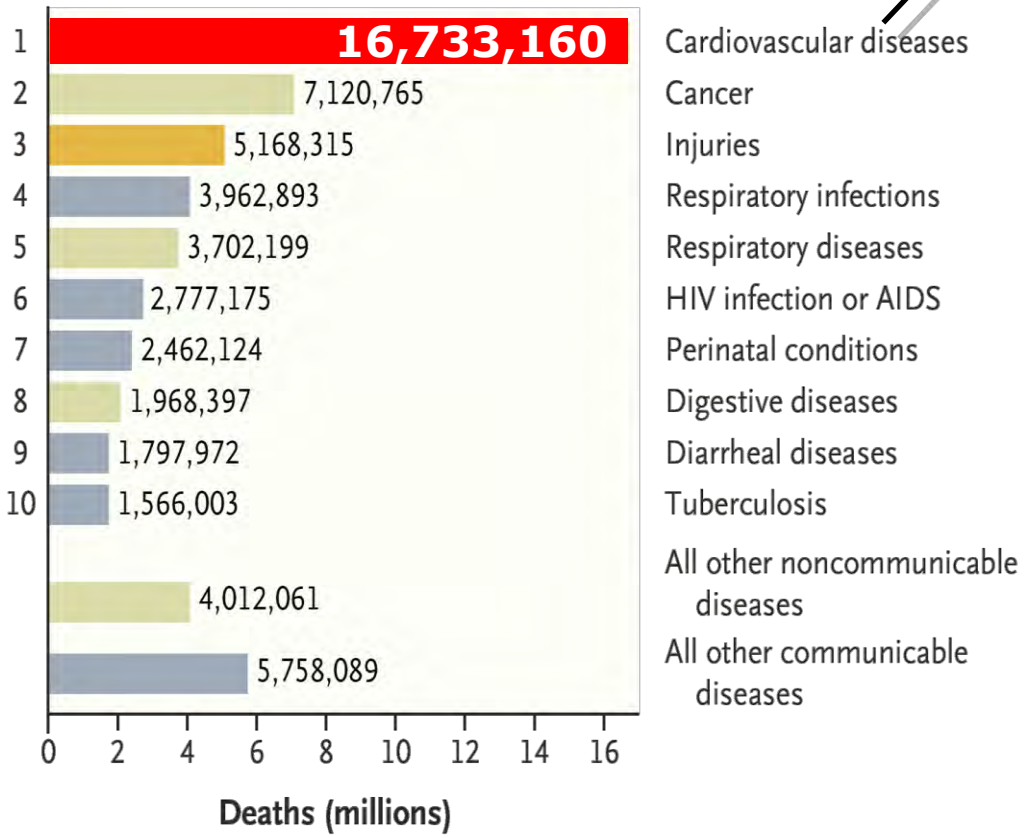
2.2%). Screening with history and examination alone detected abnormalities in 5 of these 11 athletes (sensitivity, 45.5% [95% CI, 16.8% to 76.2%]; specificity, 94.4% [CI, 92.0% to 96.2%]). Electrocardiography detected 5 additional participants with cardiac abnormalities (for a total of 10 of 11 participants), thereby improving the overall sensitivity of screening to 90.9% (CI, 58.7% to 99.8%). However, including ECG reduced the specificity of screening to 82.7% (CI, 79.1% to 86.0%) and was associated with a false-positive rate of 16.9% (vs. 5.5% for screening with history and examination only).

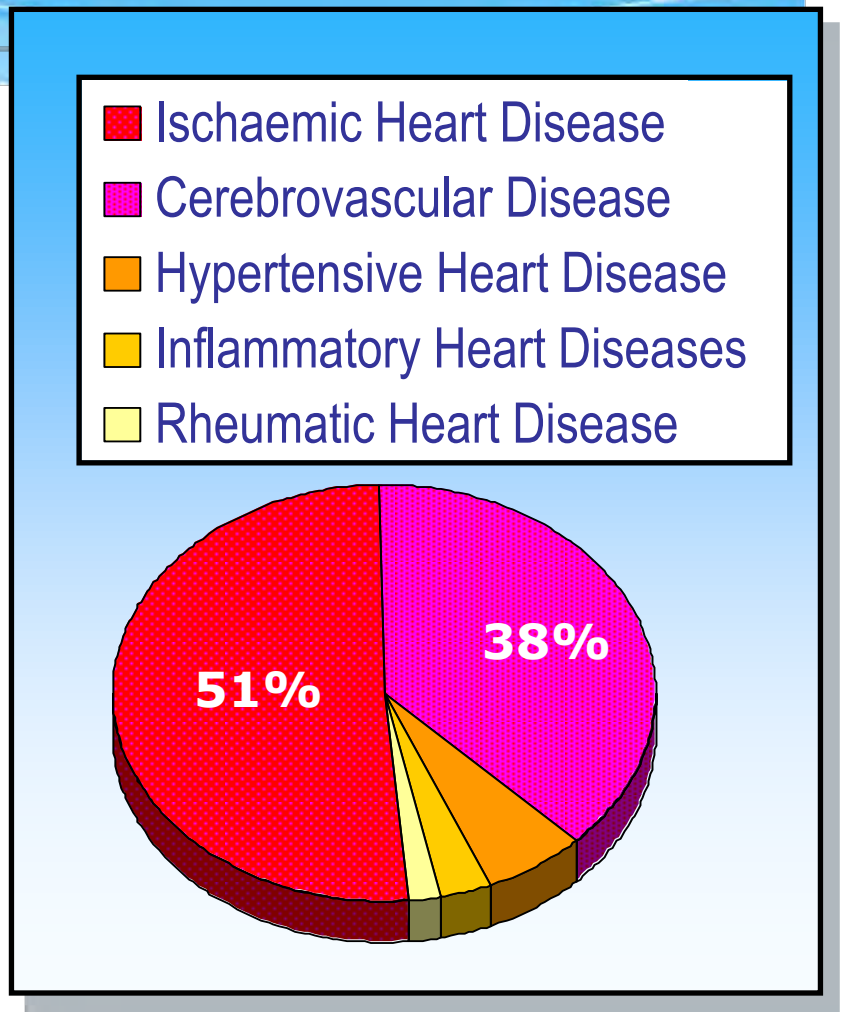
Limitation: Definitive conclusions regarding the effect of ECG inclusion on sudden death rates cannot be made.

Conclusion: Adding ECG to medical history and physical examination improves the overall sensitivity of preparticipation cardiovascular screening in athletes. However, this strategy is associated with an increased rate of false-positive results when current ECG inter-

Cardiovascular Diseases: World's "No. 1 Killer"

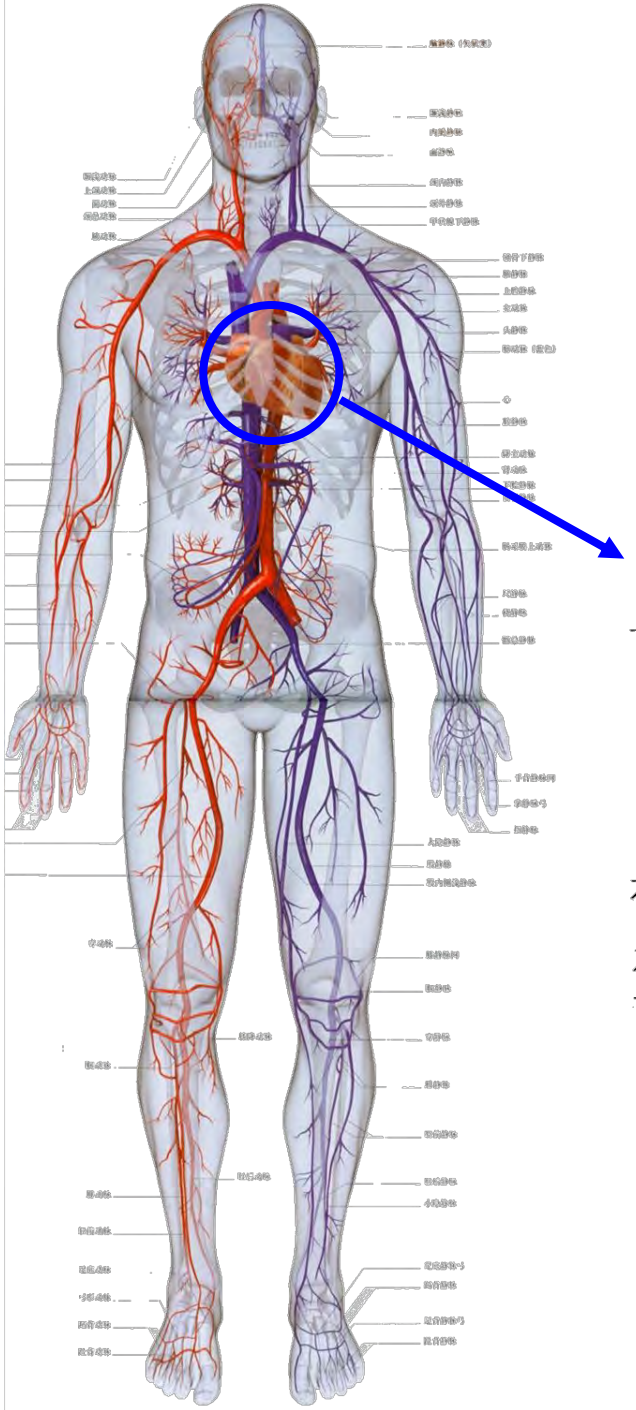
Global Top Ten Causes of Death

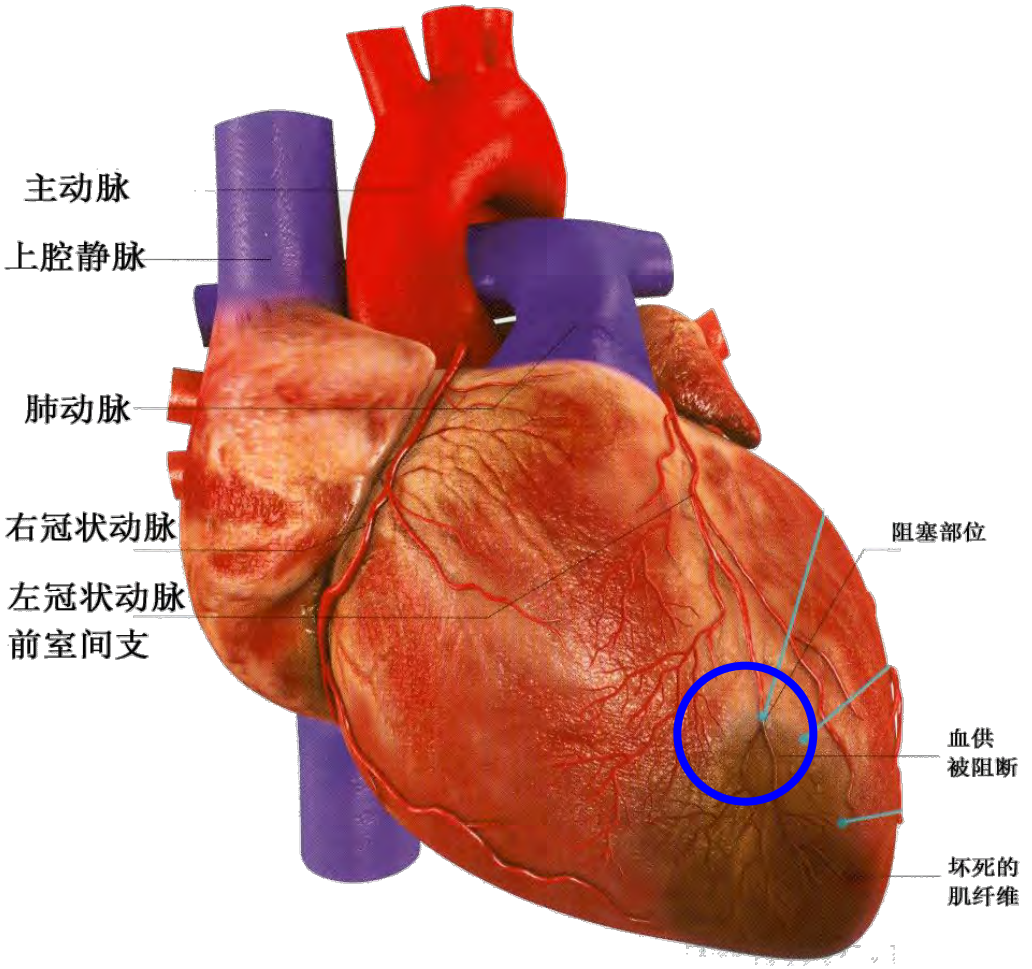




Sources: WHO Statistics, estimated total deaths by cause, 2002;
Confronting Chronic Disease in Countries with Low Income, *N Engl J Med*, 2007, vol. 356, pp. 209–211.

Is there a common cause to acute myocardial infraction and stroke?

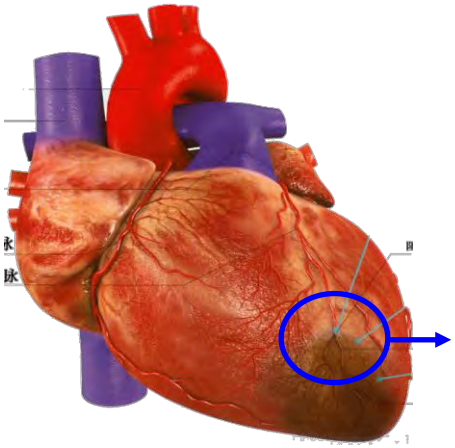


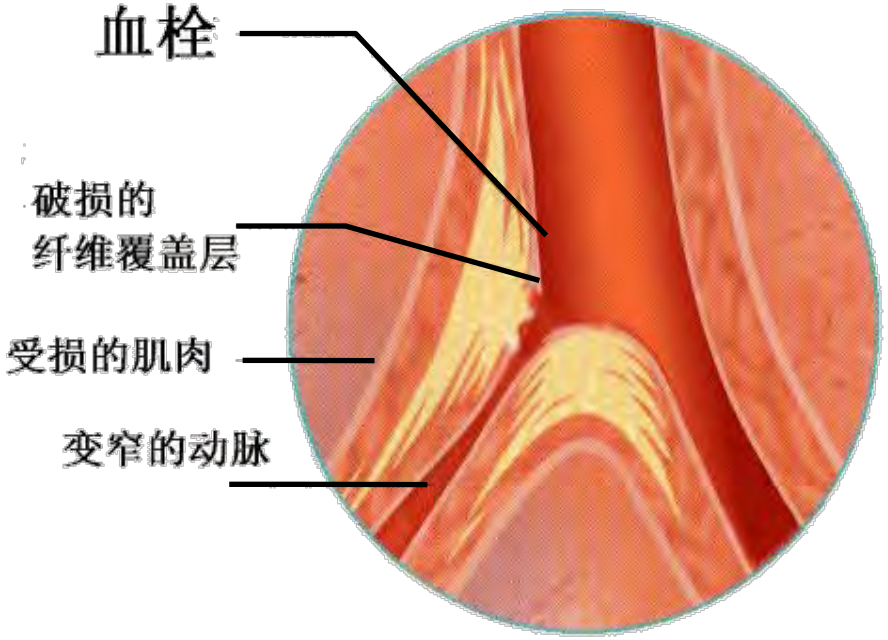


——The Human Body Book, Steve Parker, DK

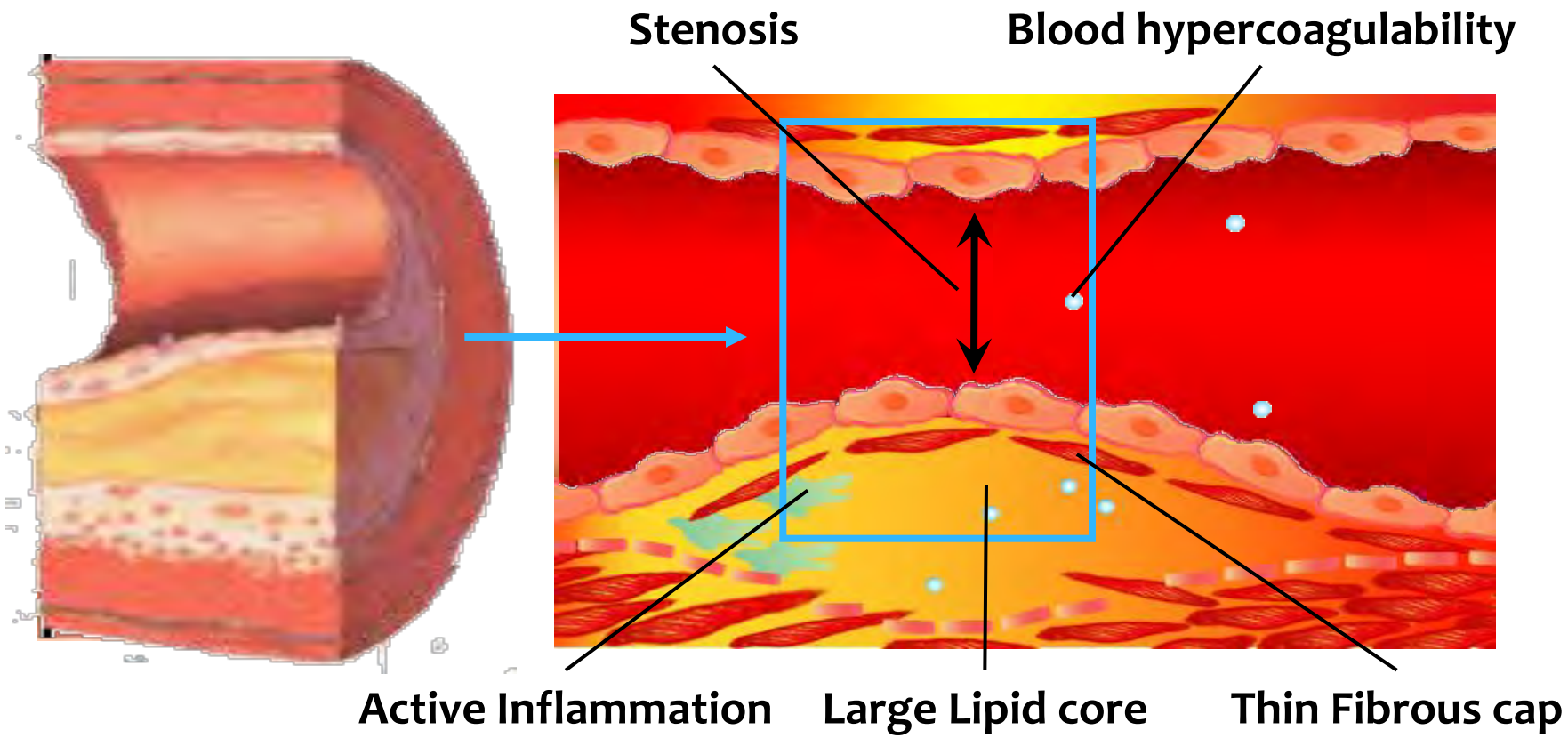
Mechanism Underlying Acute CV Events

* **Rupture** of atherosclerotic **vulnerable plaque** with **thrombosis** is the pathologic mechanism responsible for the majority of acute myocardial infarctions (AMI) and sudden coronary death (SCD)



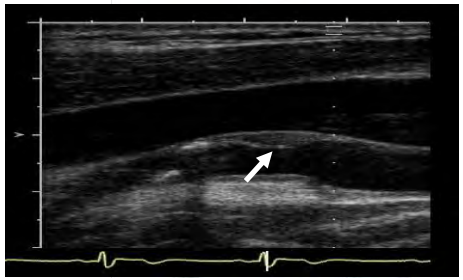


Vulnerable Plague: The Substrate



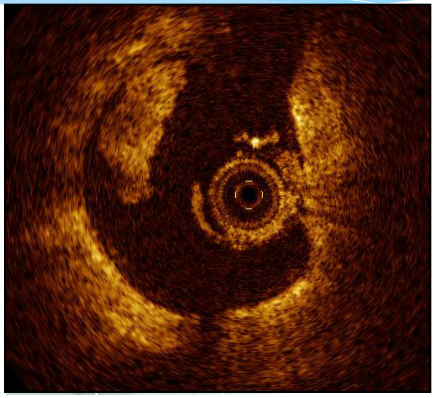
- **The use of serological and blood markers**
- **Multi-modal imaging to identify the structural and functional properties of the plaque**

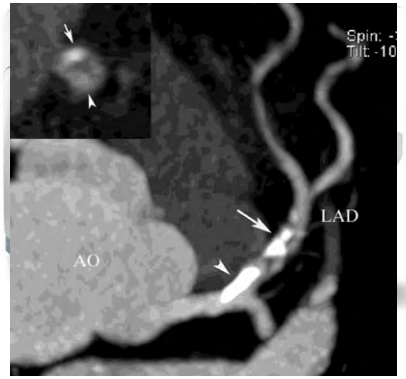
Imaging the Vulnerable Plaque



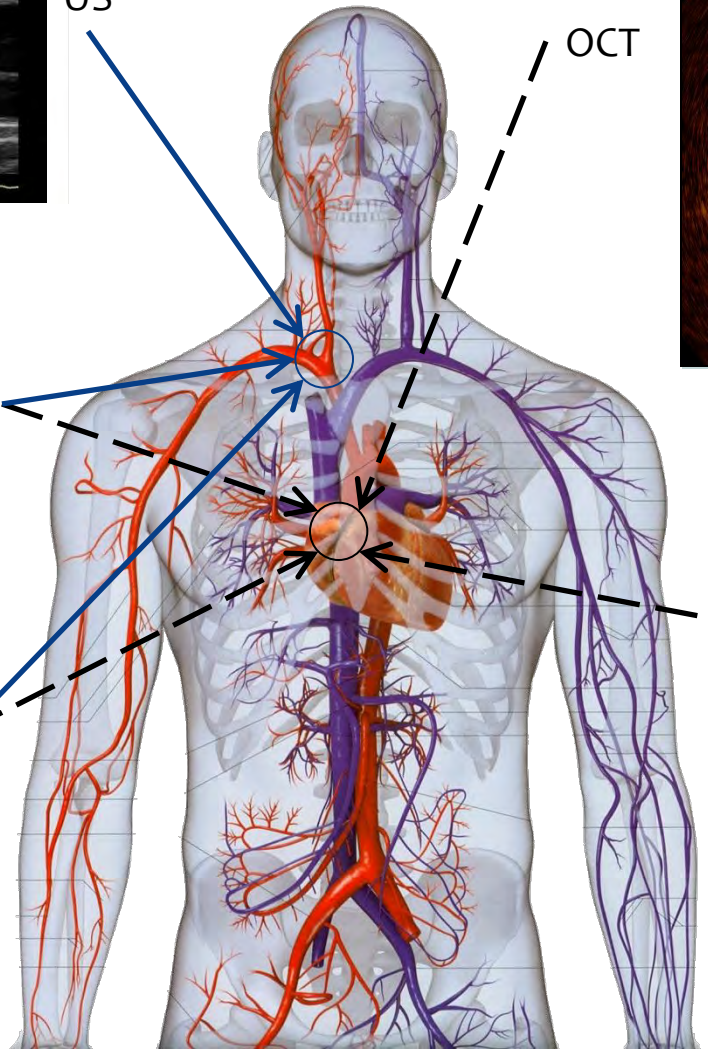
US

OCT



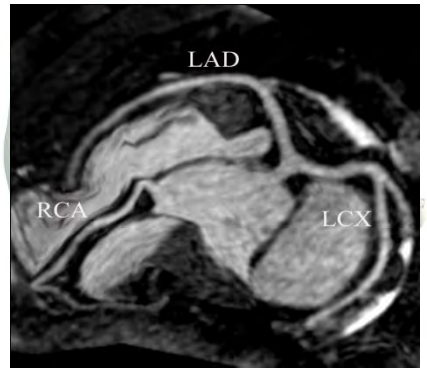


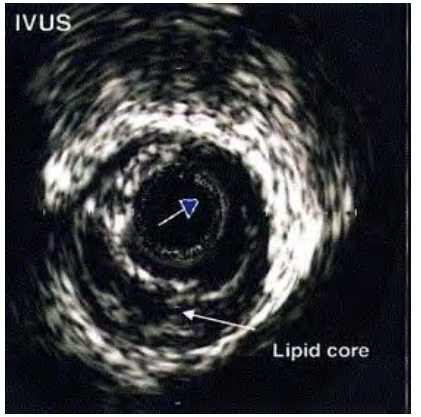
CT



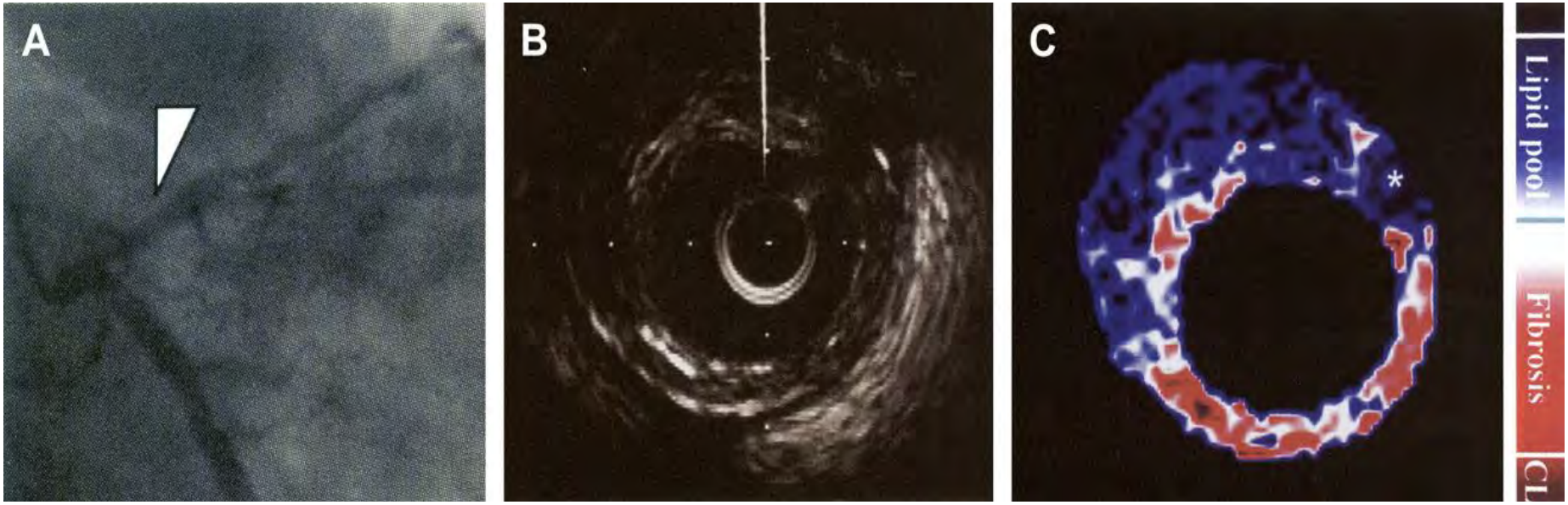
IVUS

MRI





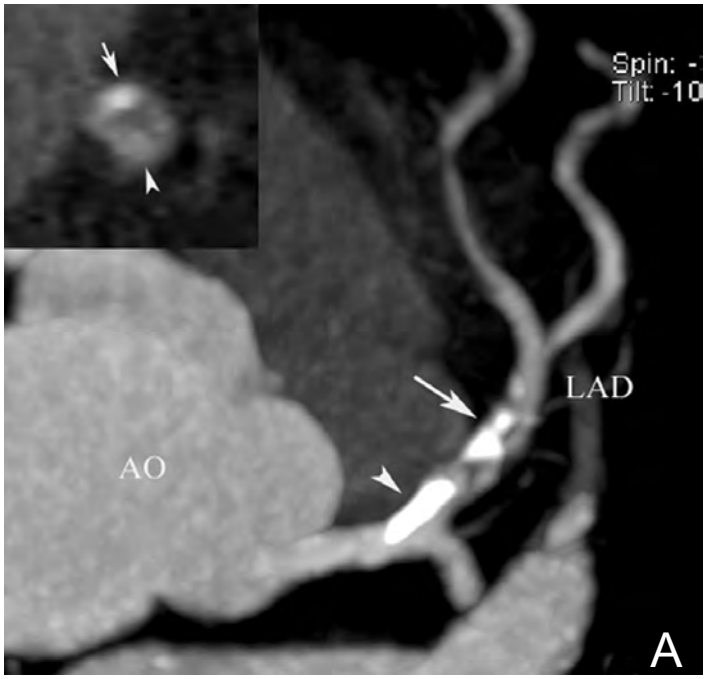
Plaque Imaging

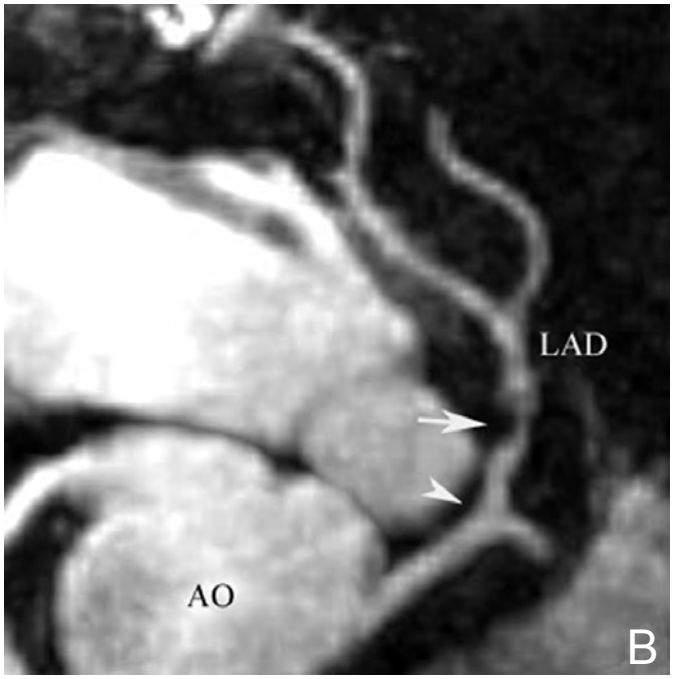


(A) 左冠狀動脈血管照相術 (B) 圖A中箭頭指示部位的IVUS成像 (C) 集成背向散射(IB)-IVUS成像, 大脂質核心（藍色）伴纖維帽（紅色或白色）

J. G. Kips, P. Segers, L. M. van Bortel, Identifying the vulnerable plaque: A review of invasive and non-invasive imaging modalities, Artery Research, 2, 21-34, 2008.

Plaque Imaging

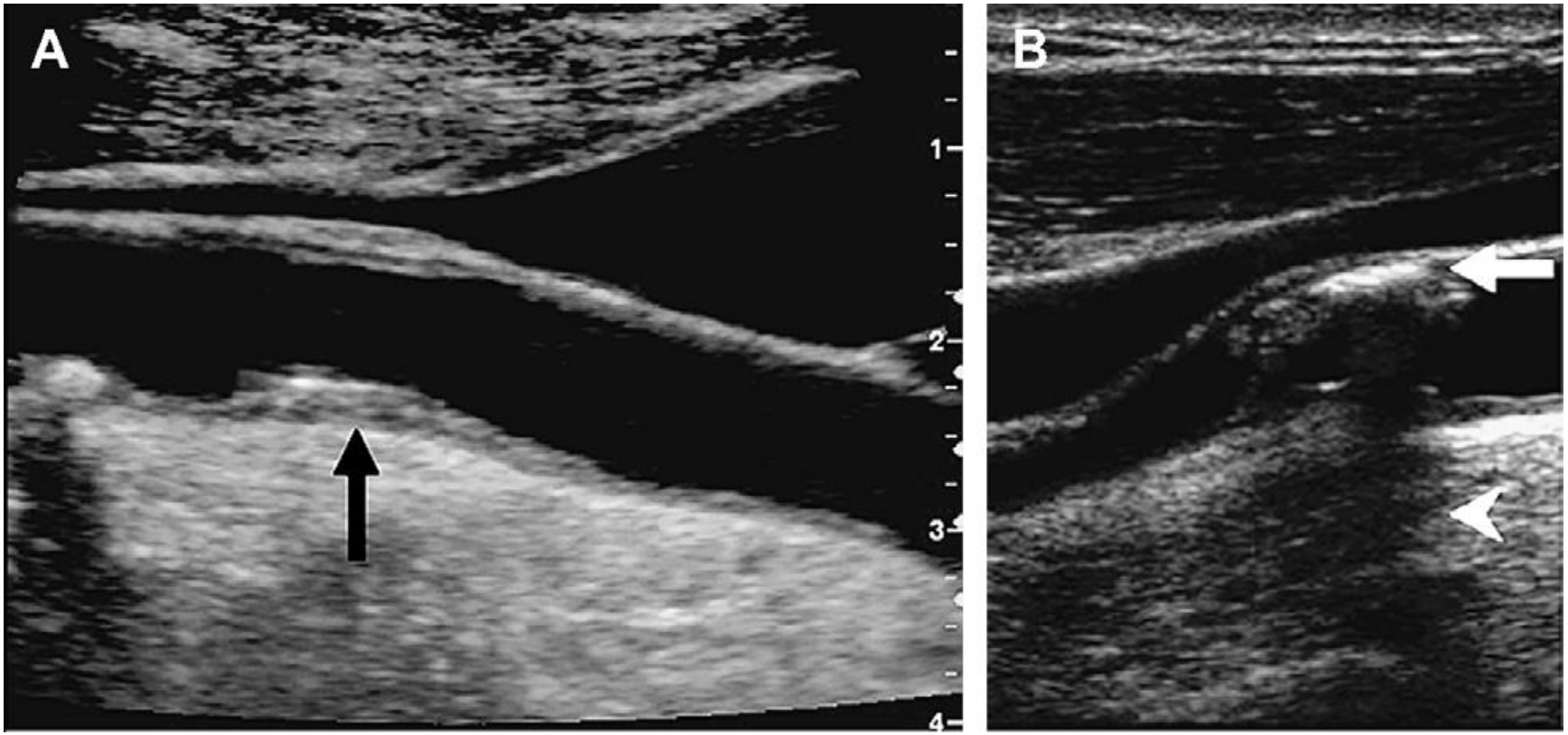




CT血管造影顯示冠狀動脈主干鈣化斑塊（**A,**箭頭）和前降支近段混合斑塊（**A,**箭）。**MRI**冠狀動脈成像顯示主干斑塊所在處無管腔狹窄（ **B,**箭頭）而前降支近段斑塊所在處有顯著狹窄（**B,**箭）。

AJR American Journal of Roentgenology 2007;189:1326-1332.

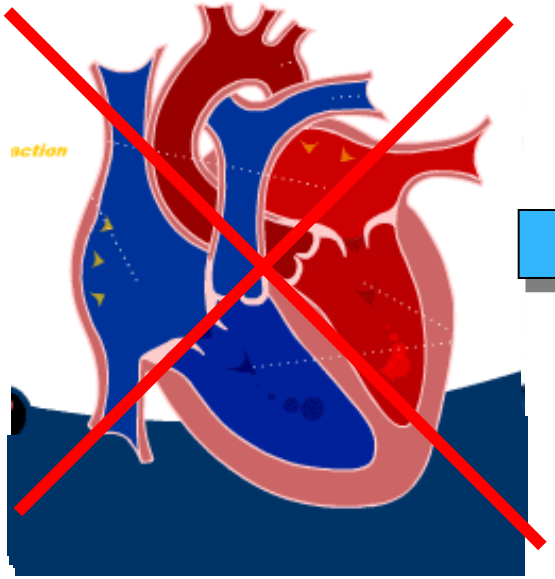
Plaque Imaging

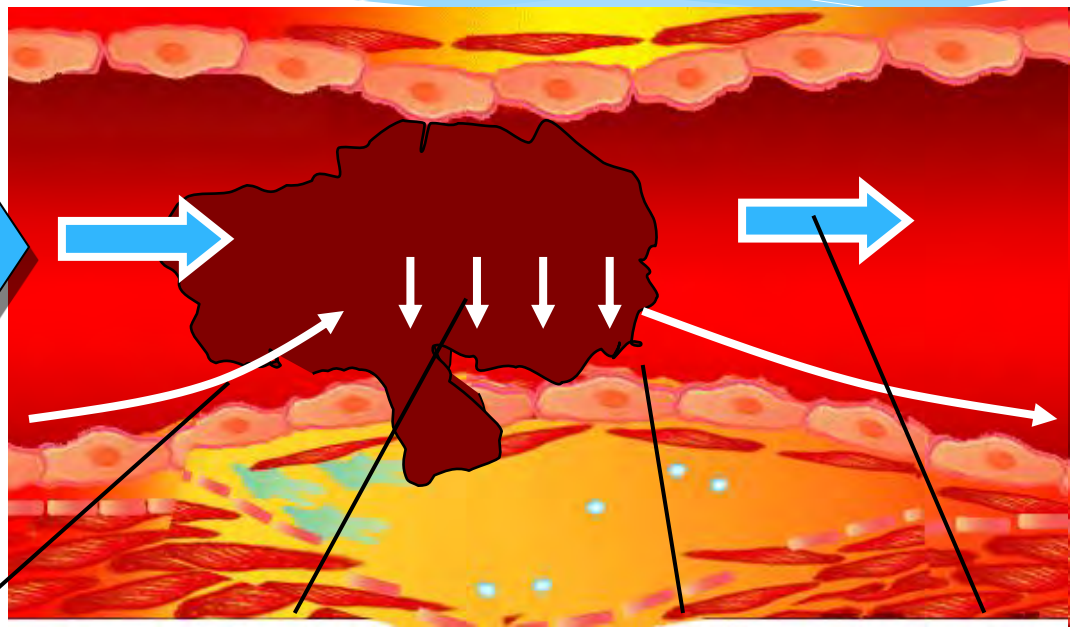


超聲成像：(A)頸動脈富含脂質斑塊 (B)頸動脈鈣化斑塊

Trends Cardiovasc Med, 15(1), 17-24, 2005.

VP Rupture – The Triggering Event



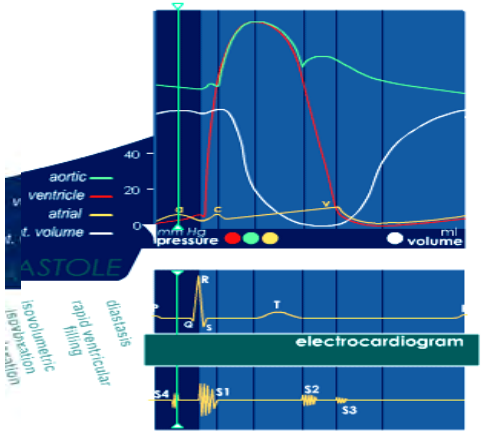


Shear stress

Vertical stress

Oscillation frequency

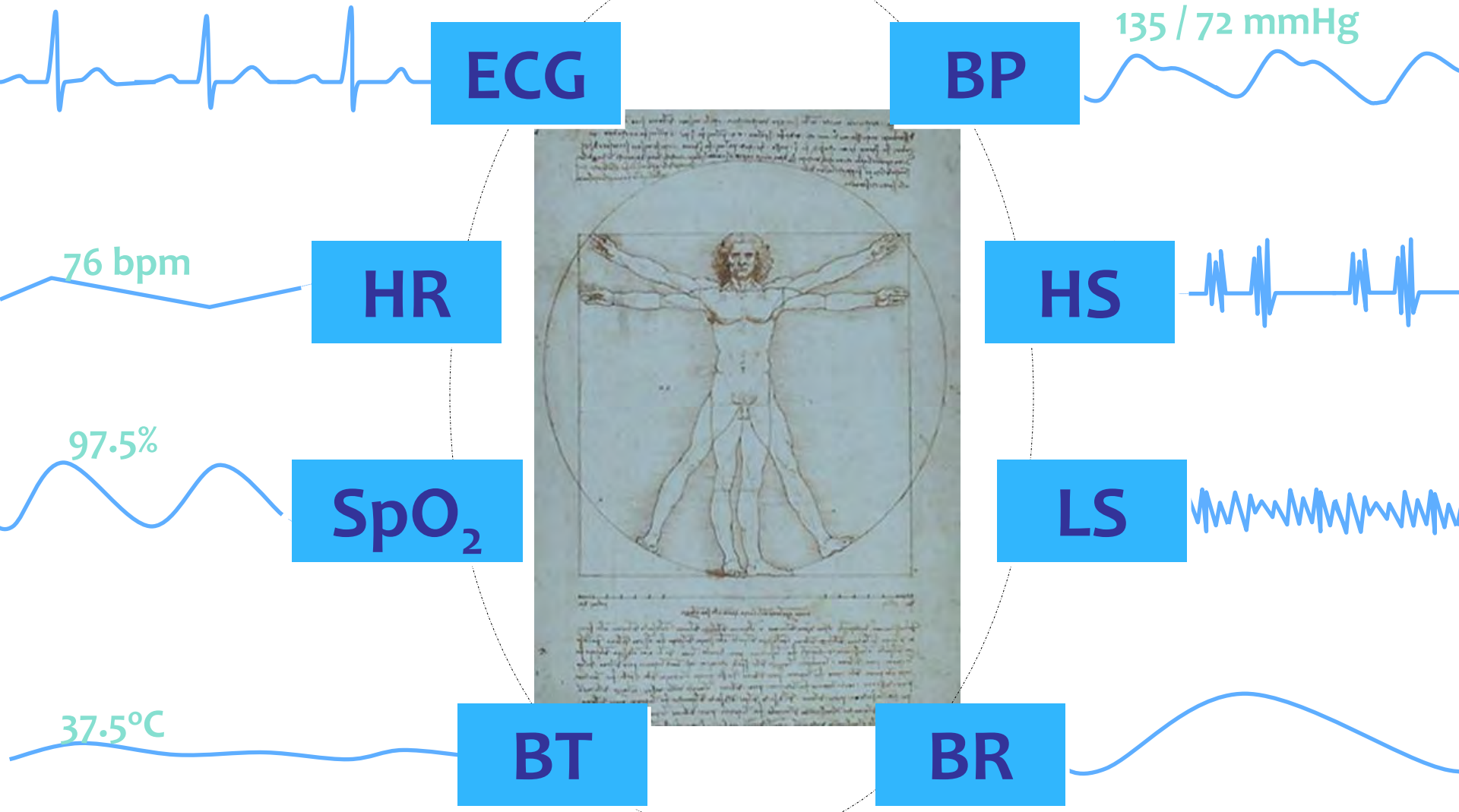
Blood flow



- Heart rate and HR variability
- Blood pressure and BP variability
- Pulse transit time and PTT variability

- On-body continuous measurement of the physiological triggering factors

Vital Signs



AHA/ASH/PCNA Joint Scientific Statement

Call to Action on
Use and Reimbursement for Home Blood Pressure Monitoring

American Heart Association

American Society of Hypertension

PCNA
Preventive Cardiovascular Nurses Association

Hypertension, 52:1-9, May 2008

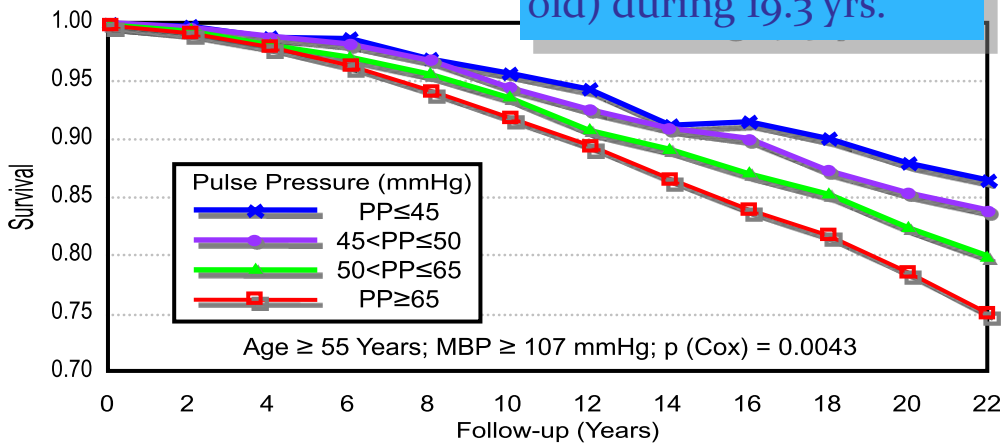
Home blood pressure readings are more reproducible than office readings and show better correlations with measures of target organ damage. They should become a routine component of BP measurement in the majority of patients with known or suspected hypertension.

Hypertension
Journal of the American Heart Association

BP, BPV: CV Mortality Indicators

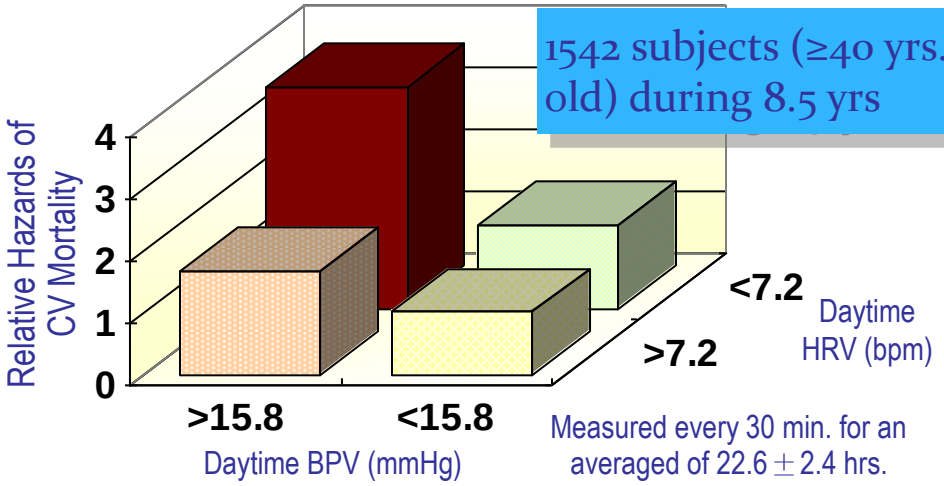
French Study, 2006

19083 males (40-49 yrs. old) during 19.3 yrs.



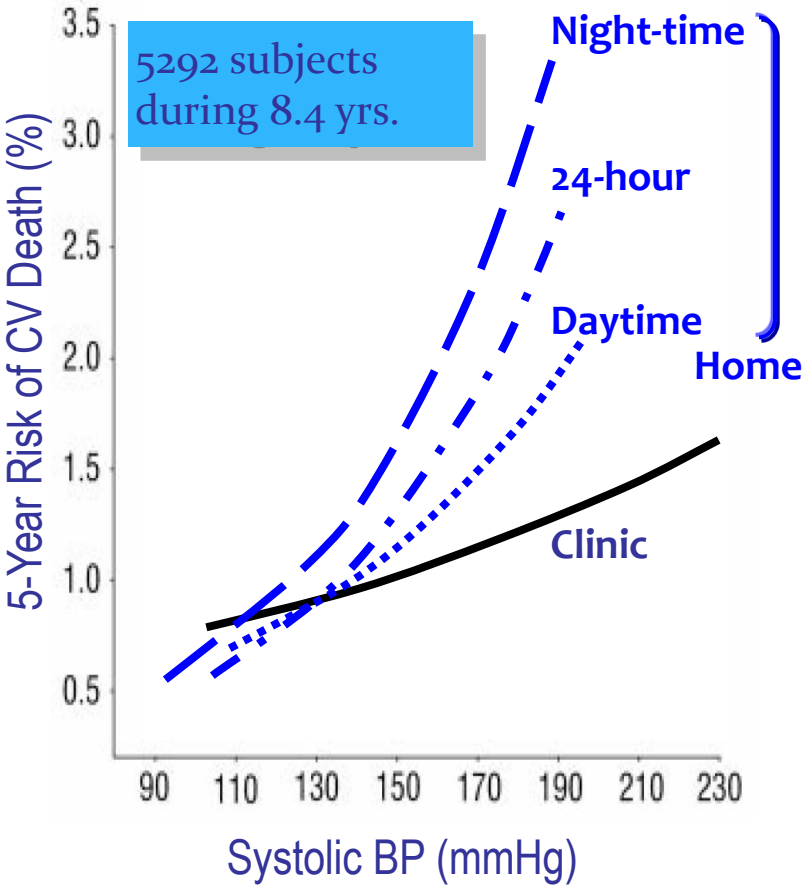
Ohasama Study, 2000

1542 subjects (≥40 yrs. old) during 8.5 yrs



Dublin Study, 2005

5292 subjects during 8.4 yrs.



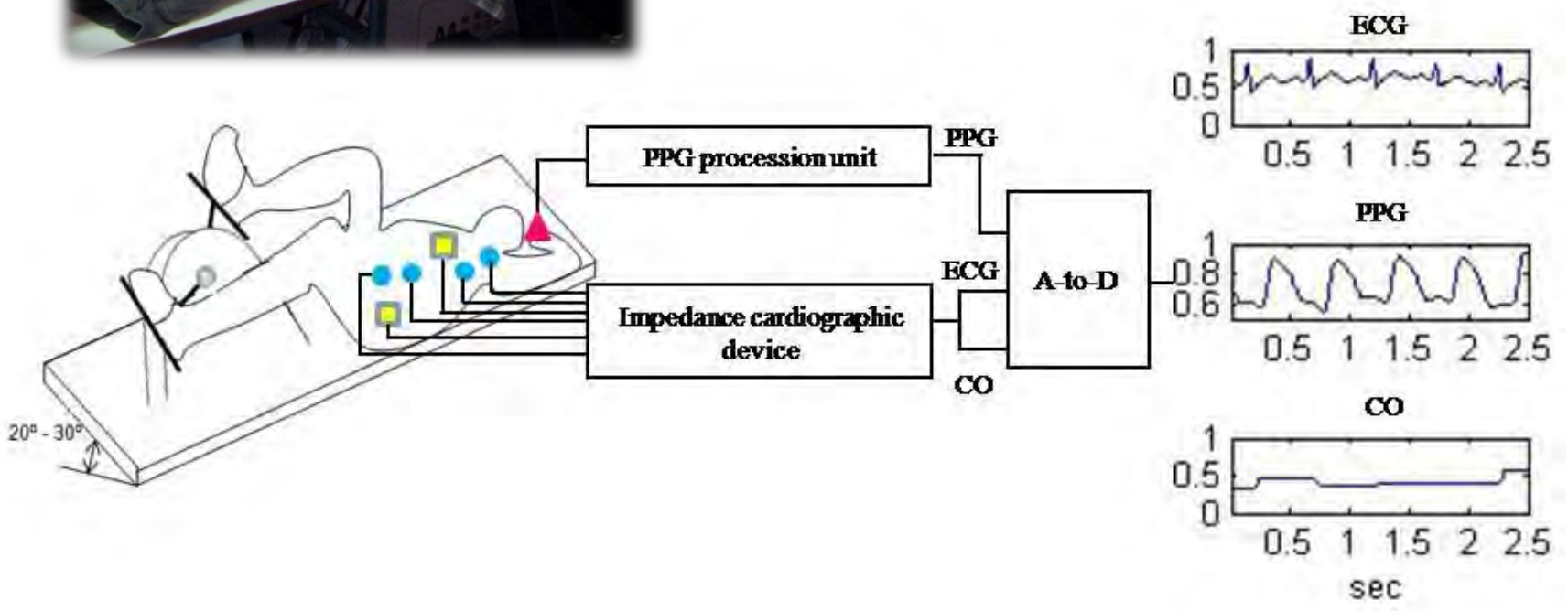
Dolan *et al.*, *Hypertension*, 46:156-61, 05

Blood Pressure Measuring Devices

- Bulky
- Large Power Consumption
- Discomfort cuff measurement
- Cannot provide long-term, continuous readings

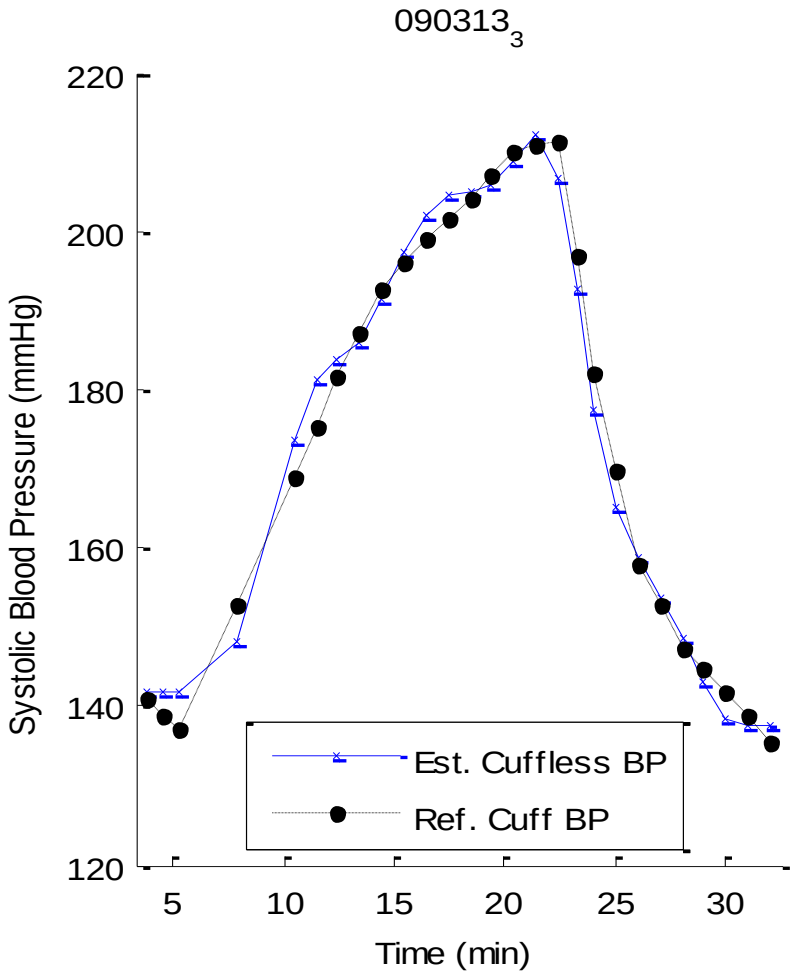
Validation Protocol

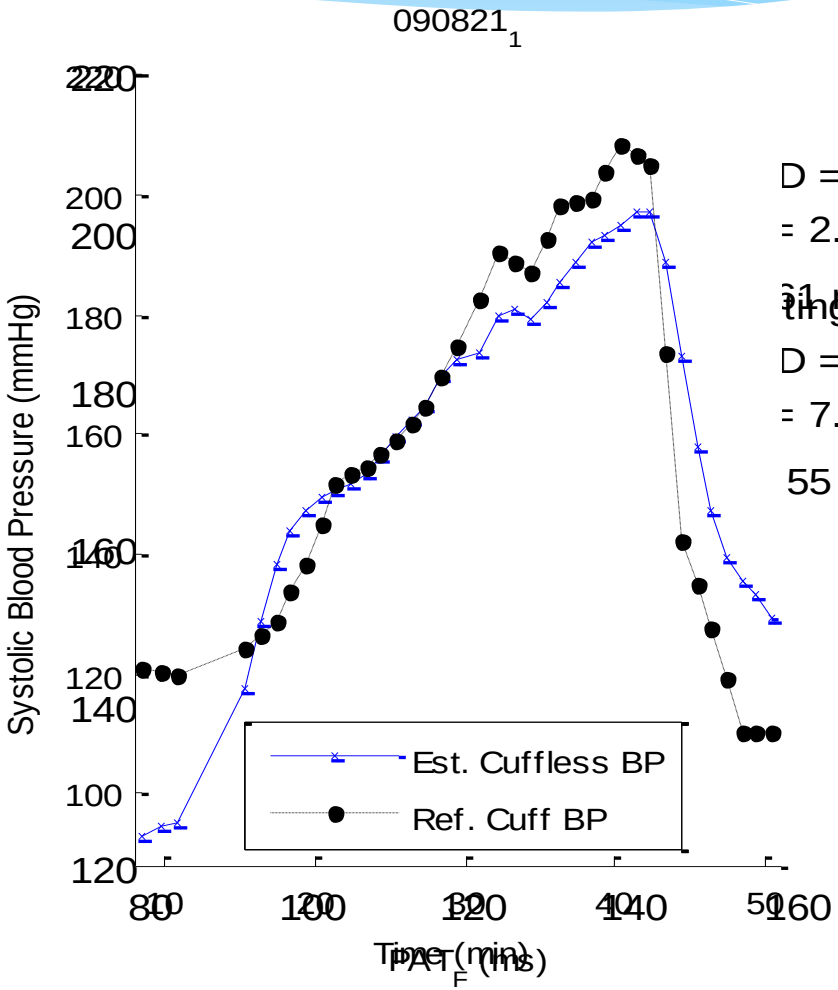
Collaborative with Yip & Yu,
Division of Cardiology,
Prince of Wales Hospital



- *L. Wang, C.C.Y. Poon and Y.T. Zhang, "Model-based non-invasive and continuous cardiac output estimation using photoplethysmography in an exercise study," (2010) Physiol. Meas.* ***31****:715.*

Typical Results





- C.C.Y. Poon and Y.T. Zhang, "Development of Wearable Technologies for Myocardial Infarction and Stroke Screening and Intervention within Nations (MISSIoN)," submitted to IEEE-EMBC 2011.

Consecutive Bouts of Exercise

Condition	Trial No.	Time Period
Before Exercise	1	5 min
Before Exercise	2	5 min
Treadmill Exercise at 9 km/h	--	3 min
After Exercise	3	5 min
Treadmill Exercise at 9 km/h	--	3 min
After Exercise	4	5 min
Treadmill Exercise at 7 km/h	--	3 min
After Exercise	5	5 min

CV Variabilities Before & After Exercise

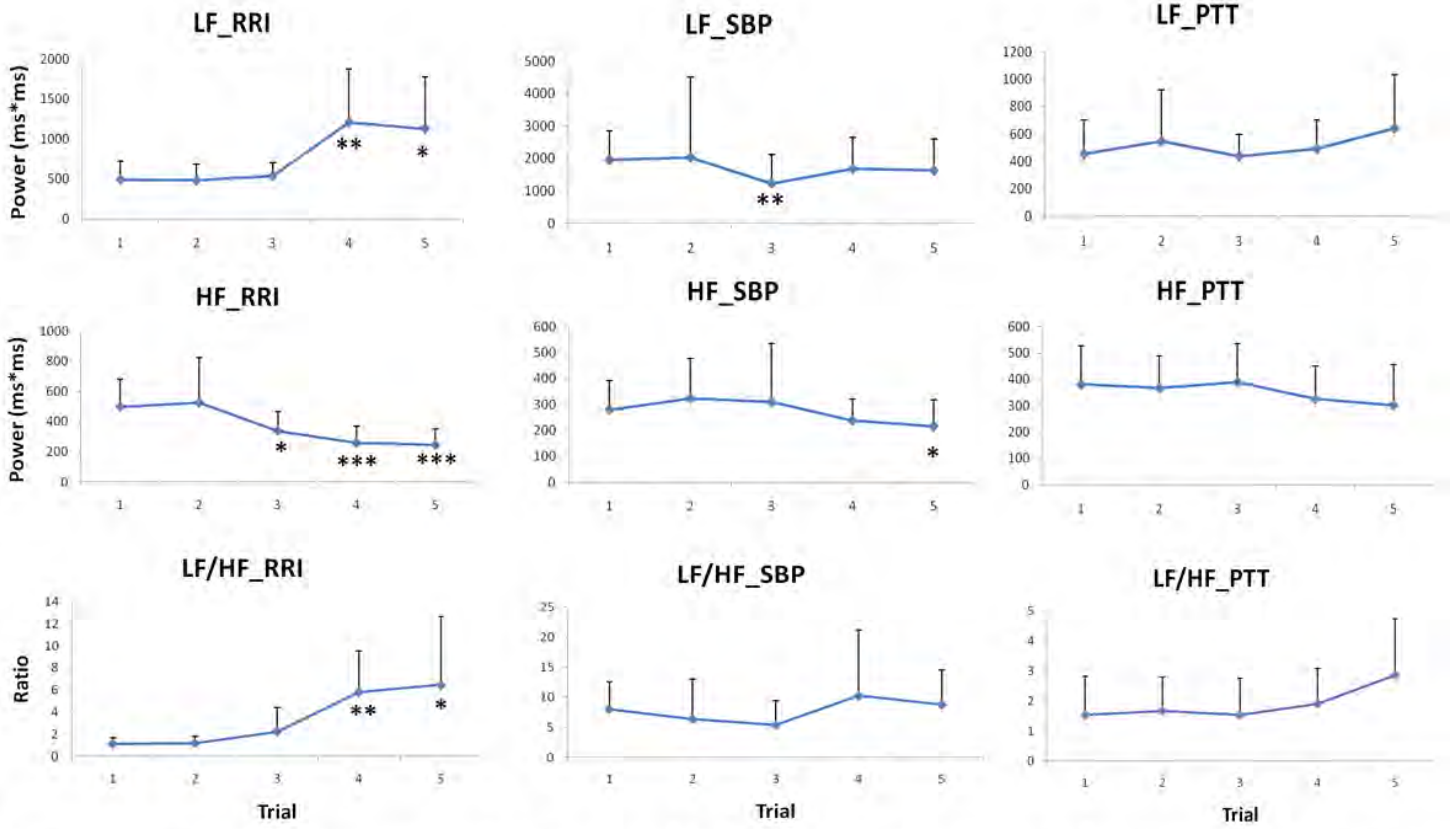
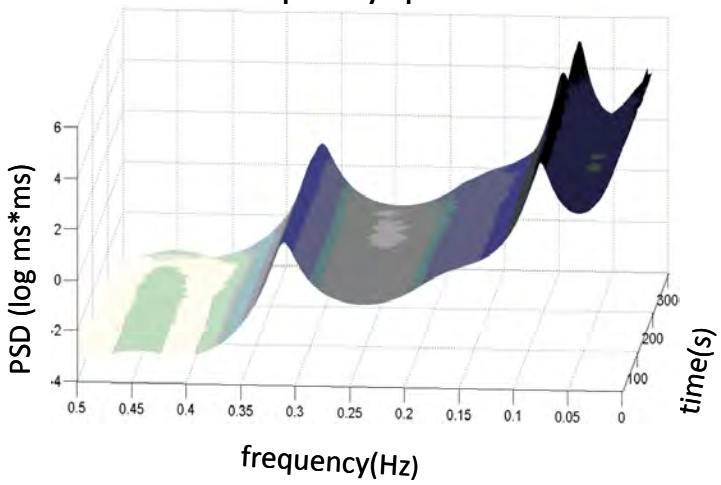


Fig. 5 Comparison of LF, HF power and LF/HF ratio of RRI, SBP and PTT before and after exercise. Trial 1: resting 1 before exercise; Trial 2: resting 2 before exercise; Trial 3: after exercise 1; Trial 4: after exercise 2; Trial 5: after exercise 3. Paired Student's t-test was employed to exam the significance of difference between trials 2~4 and trial 1 (**P*<0.05; ***P*<0.01; ****P*<0.001).

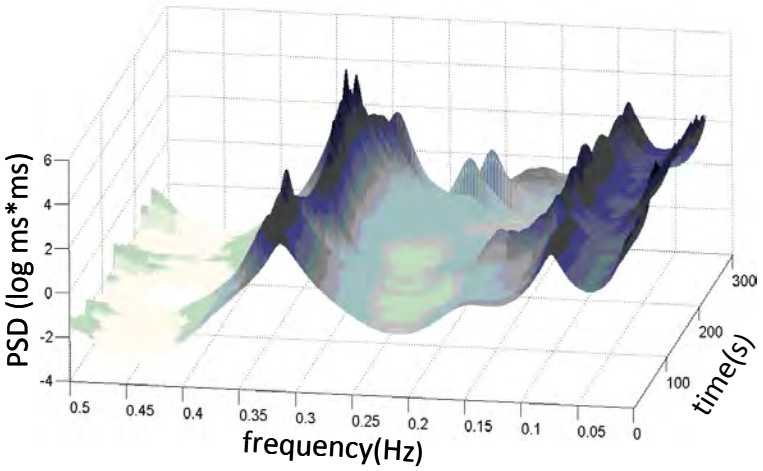
AR Model of CV Oscillations

$$x(n) = \sum_{k=1}^{p} a_k x(n-k) + \varepsilon(n)$$

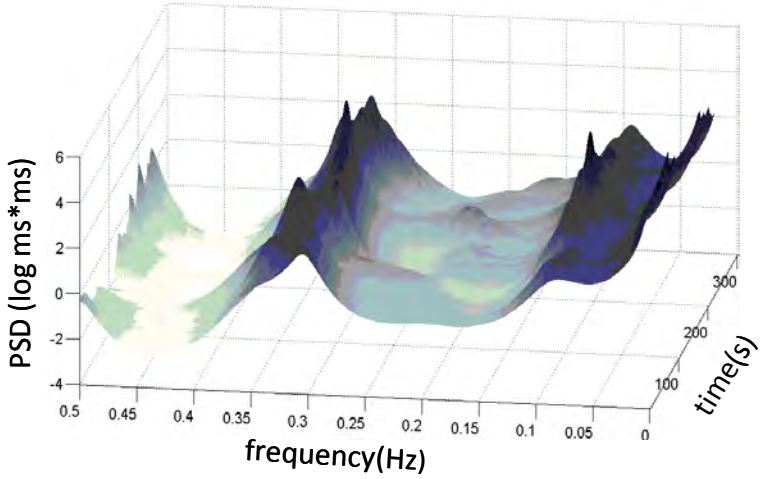
Time-frequency spectrum of SBP



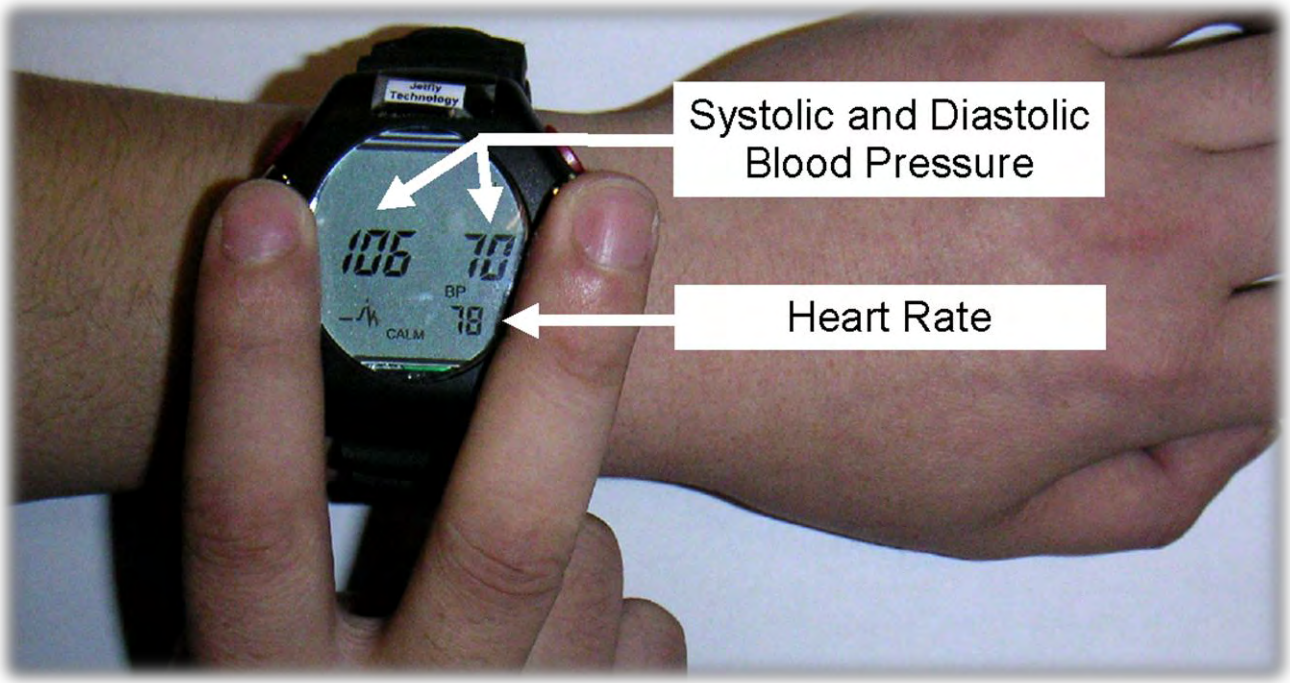
Time-frequency spectrum of RRI



Time-frequency spectrum of PTT



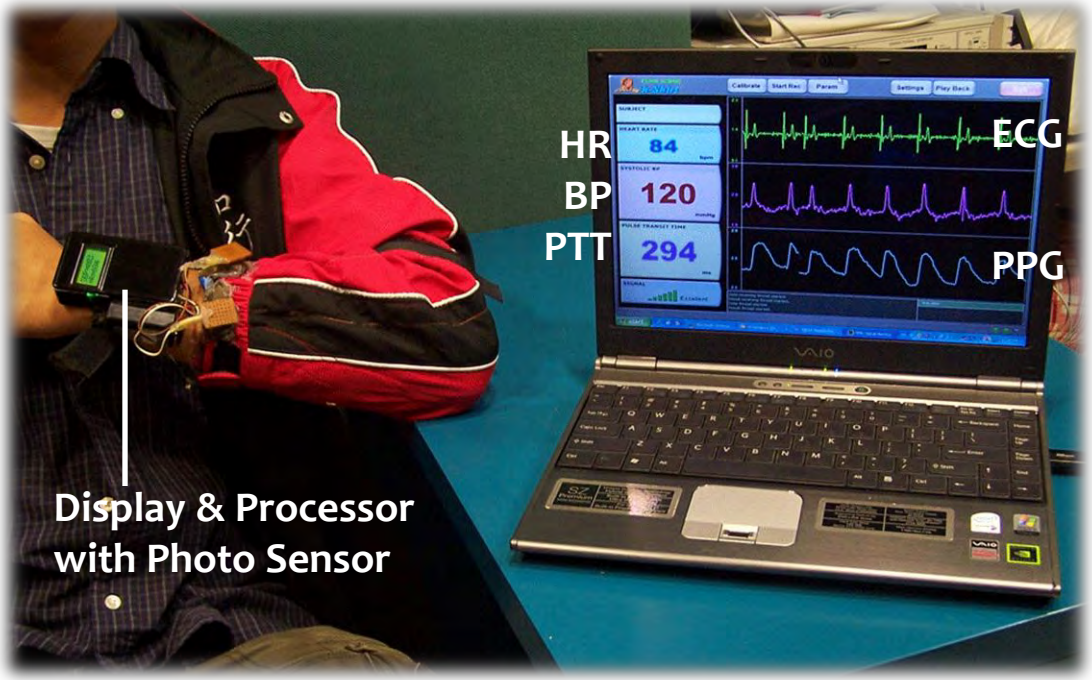
Blood Pressure Watch



A prototype of the cuff-less BP watch produced by Jetfly Technology Ltd. using the PTT-based technology developed at JCBME.

C.C.Y. Poon, Y.M. Wong and Y.T. Zhang, in *Proc. of IEEE/NLM Life Science Systems and Applications Workshop*, NLM, NIH, Bethesda, USA, 13-14 Jul., 2006.

Health Shirt (h-Shirt)



* Continuous measurement of multiple physiological signals & parameters, e.g. heart rate & blood pressure
* Wireless connection for remote diagnosis and display

- W.B. Gu, C.C.Y. Poon, et al., "A h-Shirt-Based …," in *BSN 2009*, Berkeley, USA.
- Y.T. Zhang, C.C.Y. Poon, et al., "A health-shirt using e-textile …," in *MDBS* 2006, MIT, USA.

Conclusions

* Wearable intelligent systems have been developed for continuous estimation of multiple cardiovascular parameters, which can potentially be used for guiding exercise intensity, assessing training effects and monitoring health status of athletes.

Acknowledgement

- Hong Kong Innovation Technology Fund

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- Guangdong LCHT Innovation Research Team Fund

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Overview of IEEE EMBS Hong Kong Chapter

EMB

IEEE

Hong Kong Chapter

Website: www.ieee.org.hk/EMBS

E-mail: embs.hk@ieee.org

IEEE EMBS

* **IEEE Engineering in Medicine and Biology Society** is the world's largest individual-membership-based international society of biomedical engineers.
* The organization's 8,200 members reside in some 70 countries around the world.
* IEEE EMBS members by employment:
  - 52% work in academic institutions (15% of those are in medical curricula)
  - 46% work in industry (12% work specifically in the medical industry)
  - 2% work in government

IEEE EMBS Hong Kong Chapter

* The IEEE-EMBS Hong Kong Chapter was founded in September 2006.
* Initial no. of members: 28
* Working style: *Learning by Doing*

Front (left to right): Xiaofei Teng, Max Meng, Paul Cheung, Heather Ma, Kevin Hung
Back (left to right): Edmund Lam, Bryan So, William Hau, Fei Chen, Carmen Poon
Advisor : Yuan-Ting Zhang (CUHK)

Achievements

* We now have over 45 members.
* Outstanding Chapter Award Winner

2009 EMBS
Outstanding Chapter Award

Hong Kong EMBS Chapter

Committee

* We recruit committee members from different sectors – and different institutes for a balanced growth
  - University (60%), Industry (20%), Hospital (20%)
* Starting from this year, we also have members from University of Macau

Activities

* In collaboration with local universities, HKIE, HKPC, IEEE Macau, industries, academic institutes in mainland and nearby regions, we organise
  - Seminars
  - Hospital visits
  - Industry visits
  - Student paper competitions
  - Roadshow
  - Technical co-sponsor / supporter of conferences

IEEE-EMBS Hong Kong Chapter Student Paper Competition

Date: Aug 20, 2011 (Sat.) **Venue:** Room 1006, HKPC Building, 78 Tat Chee Avenue, Kowloon, Hong Kong

Awards

First prize: IEEE student member fee for one year, HK$800, and a Certificate of Merit

Second prize: IEEE student member fee for one year, HK$400, and a Certificate of Merit

Third prize: IEEE student member fee for one year and a Certificate of Merit

Important Dates

Paper submission deadline: July 16, 2011

Notification of finalist: July 23, 2011

Final competition: From 9am to 1pm, August 20, 2011

Contact

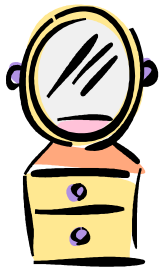
For more information, please contact the executive secretariat

Prof. Carmen C.Y. Poon

Looking Ahead …

* More benefits for members, especially students
* Collaborations with …
  - Local BME-related organizations
  - Universities in Pearl-River Delta Region
  - Medical device industries
  - ***Sports science professionals***

Your participation!



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Thank You !

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