

Longest period with CC (sec)	122 (68,206)
Average period with CC (sec)	55 (43,74)
Longest period without CC (sec)	172 (109,246)
Average period without CC (sec)	57 (40,78)

Time interval data is reported as median (25%, 75%)

The American Journal of Medicine (2006) 119: 394-398

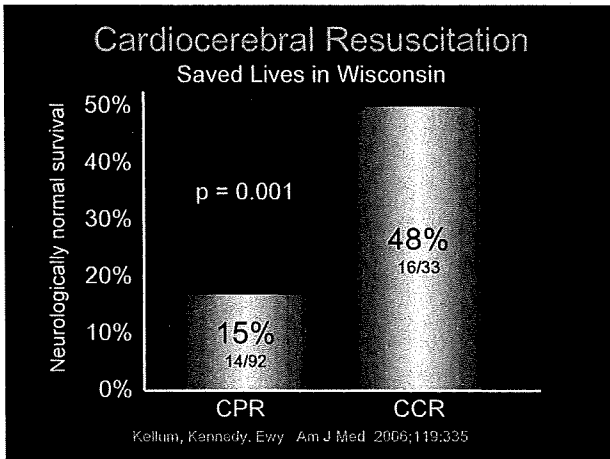
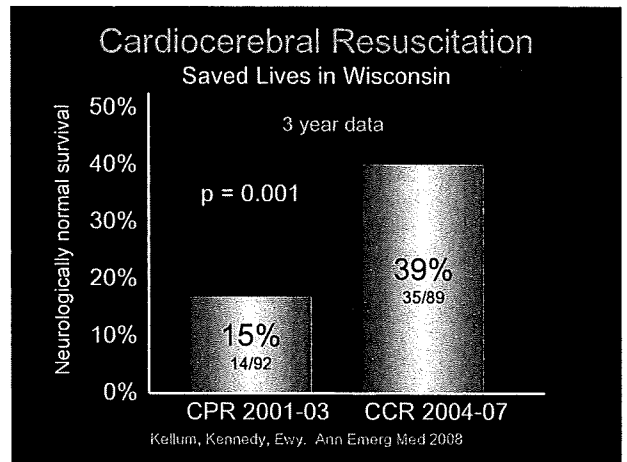
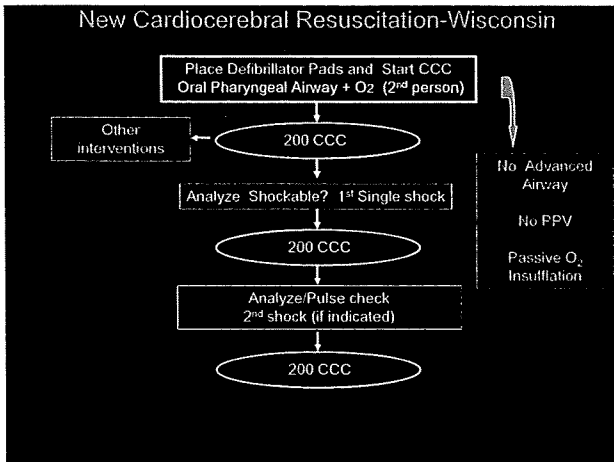
ELSEVIER

CARDIOCEREBRAL RESUSCITATION

**Cardiocerebral Resuscitation Improves Survival of Patients with Out-of-Hospital Cardiac Arrest**

Michael J. Kellum, MD,\* Kevin W. Kennedy, MS,\* Gordon A. Ewy, MD\*  
 \*Mercy Health System, Jundtsville, Wis; \*Sarver Heart Center, University of Arizona College of Medicine, Tucson

Primary Endpoint:  
 Neurologically normal survival in patients with Witnessed OOH cardiac arrest with initially shockable rhythm



### Cardiocerebral Resuscitation

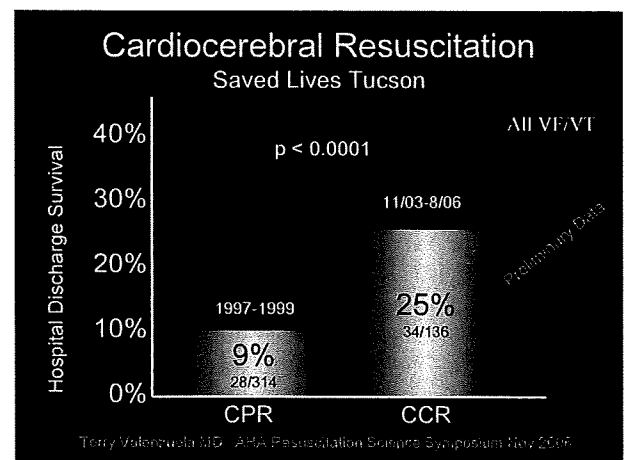
#### Three Pillars

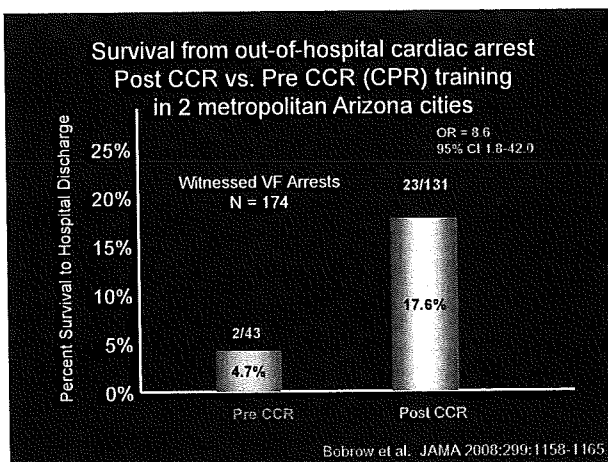
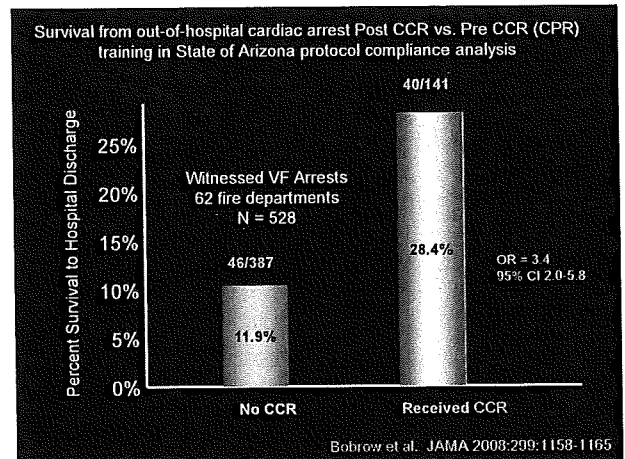
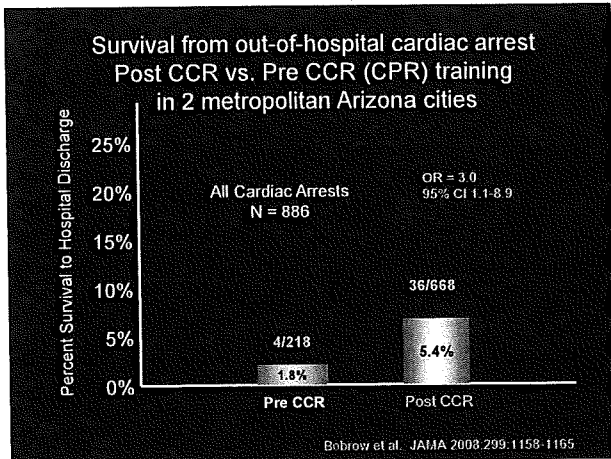
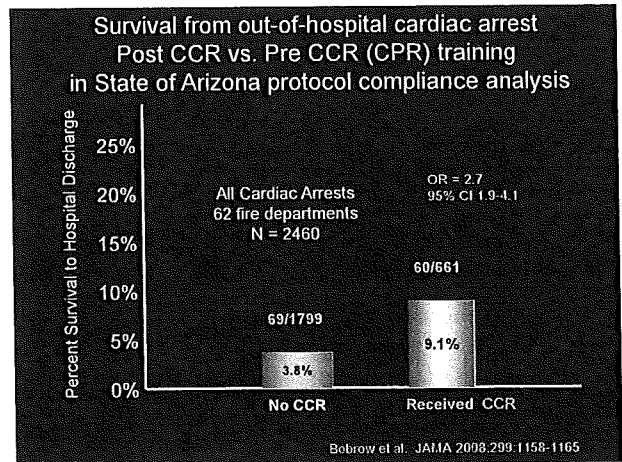
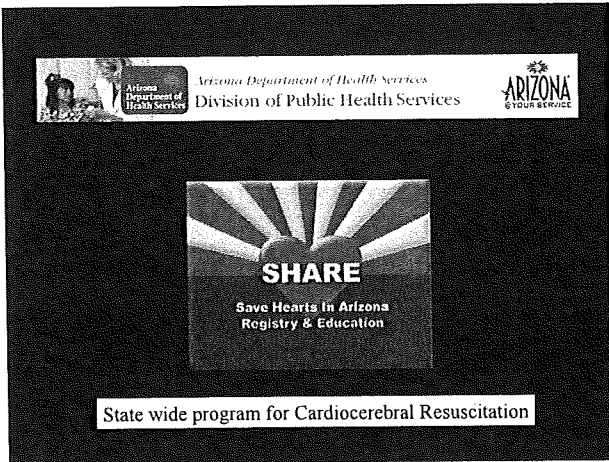
- 1 Chest Compression Only for witnessed unexpected collapse in adults
- 2 New Cardiocerebral Resuscitation ACLS algorithms for dispatchers and EMS personnel
- 3 Post Resuscitation Care

What happened if both 1. and 2. are combined in a community?

### Too Good to be True?

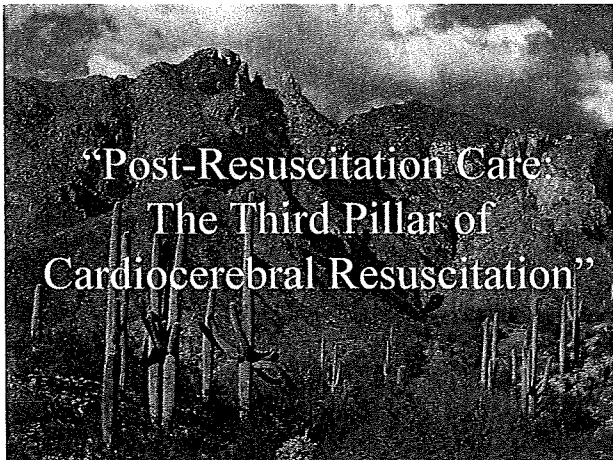
- Hawthorne effect?
- Non-randomized
- Historical Controlled





## Cardiocerebral Resuscitation

- ▣ Chest Compressions-only for Lay Rescuers:
  - "Doubled" Survival (11% to 19%)--Japan
- ▣ New ACLS Algorithm
  - "Tripled" Survival (15% to 48%)—Rural Wisconsin
  - Persistent near "Tripling" of Survival (15% to 40%) at 3 yrs
- ▣ Cardiocerebral Resuscitation— 2 Step Approach
  - "Tripled" Survival (9% to 25%)—Tucson, Arizona
  - "Tripled" Survival (5% to 18%)—Phoenix, Arizona



Can Anything Be Done About these Post Resuscitation Deaths?

### Post Resuscitation Challenge

- Only 25-50% of those initially resuscitated survive to leave the hospital!
- Truism: Can't survive if don't first resuscitate, but likewise - if you don't survive to leave the hospital haven't gained anything from earlier successful resuscitation

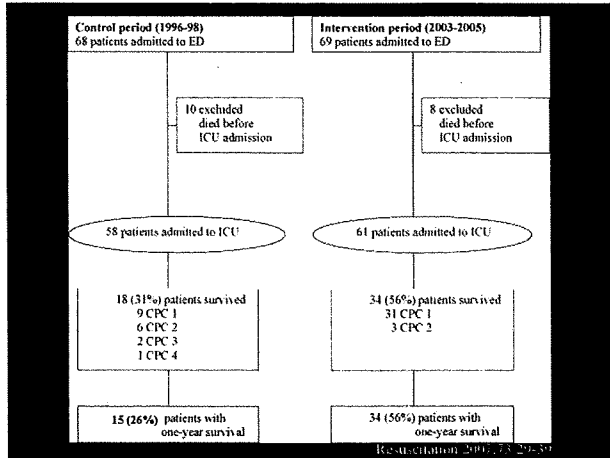
### Norway Experience

- Found their own survival to discharge was only 26% of all those initially resuscitated
- NOT GOOD ENOUGH!
- Formalized Approach to Post Resuscitation Care:
  - Therapeutic Hypothermia
  - PCI when indicated
  - Ventilation Control
  - Glucose Control
  - Hemodynamic Control

### Deaths Post Resuscitation

- About 1/3 are from CNS injury
- About 1/3 from Myocardial injury
- And about 1/3 from variety of causes, i.e. infection, multi-organ failure, etc.

Schoenenberger et al. Arch Intern Med 1992;154:2433



## Therapeutic Hypothermia Post Resuscitation

### Sunde et al.

- In the Interventional period (2003-05):
  - 47/61 (77%) had coronary angiography
    - 45/47 (96%) had documented coronary disease
    - 37 of 45 had total occlusions including
      - 16/37 (43%) LAD
      - 11/37 (30%) CX
      - 10/37 (27%) RCA
  - 30/61 (49%) had reperfusion
    - 27/30 had PCI
    - 3/30 had CABG

Resuscitation 2007;73:29-39



## The New England Journal of Medicine

Established in 1812 as THE NEW ENGLAND JOURNAL OF MEDICINE AND SURGERY  
VOLUME 346 FEBRUARY 21, 2002 NUMBER 8

Mild Therapeutic Hypothermia to Improve the  
Neurologic Outcome after Cardiac Arrest  
ET, SARA AND F.M. VERHEIJEN 549

Treatment of Comatose Survivors  
of Out-of-Hospital Cardiac Arrest  
with Induced Hypothermia  
S.A. REISSIN AND OTHERS 557

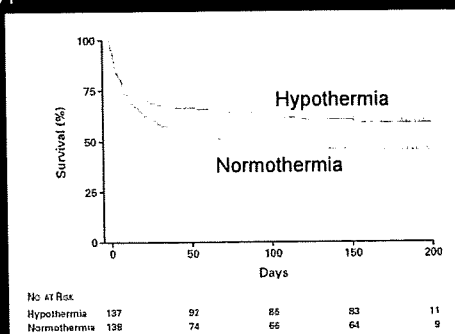
Therapeutic Hypothermia  
after Cardiac Arrest  
ET, SARA AND F.M. VERHEIJEN 612

### Sunde et al.

- Coronary angiography
  - Major indication was ST-elevation on admission ECG or strong suspicion for an MI as underlying etiology of the cardiac arrest

Resuscitation 2007;73:29-39

## Hypothermia for Coma After Cardiac Arrest



Dr. Fritz Sterz, Vienna, Austria and The Hypothermia After Cardiac Arrest Study Group. *N Engl J Med* 2002; 346:549-556

### Sunde et al.

- Significant improvement in survival, with an aggressive and standardized approach to post resuscitation care
- Reperfusion therapy (PCI or CABG) had the most profound effect on outcome (Adjusted OR = 4.47)
  - Patients were transported directly from ED to the PCI Suite when clinically stable!

Resuscitation 2007;73:29-39

## Sunde et al.

Doubled survival (26% to 56%)

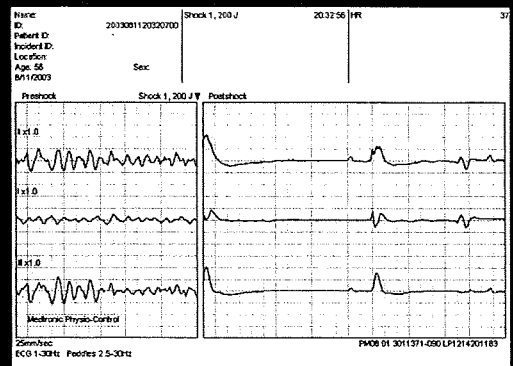
Neurological status of survivors:

31/34 (91%) were CPC = 1

3/34 (9%) were CPC = 2

Resuscitation 2007;73:29-39

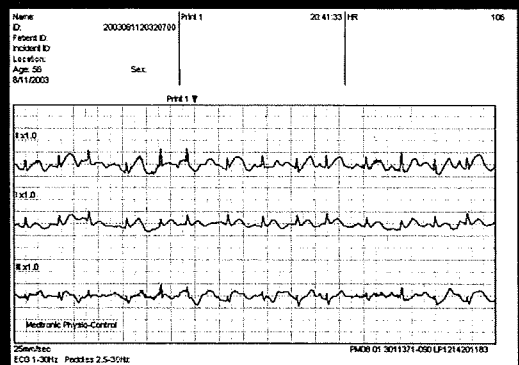
20:32:58



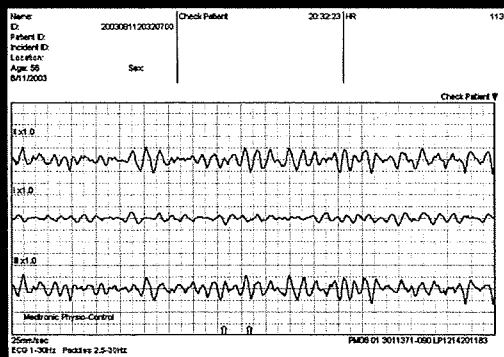
## Keys to Improving Survival to Hospital Discharge

- Good BLS/ACLS for rapid ROSC
- Therapeutic mild hypothermia for those comatose following resuscitation
- Think "Cardiac"/Look for "Cardiac"
  - 1. Early 12 lead ECG
  - 2. Early cardiac catheterization/PCI

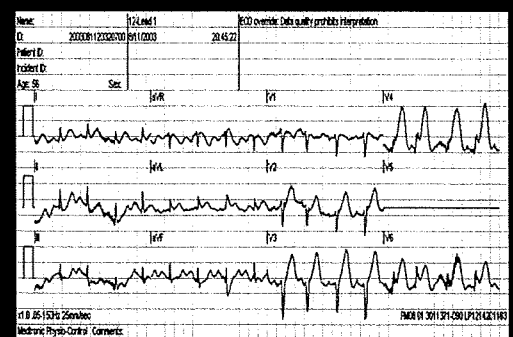
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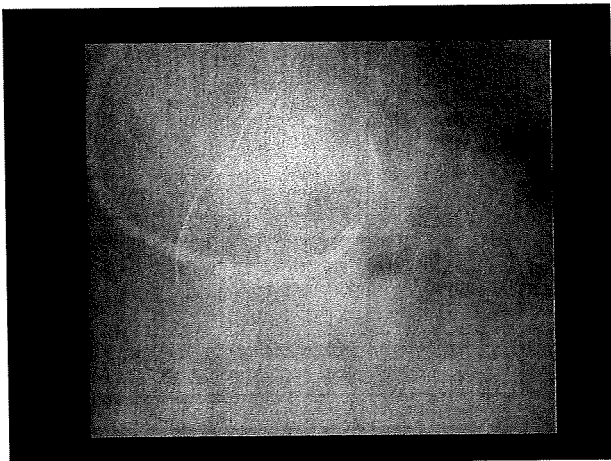


20:32:23



20:45:22





## Early Cardiac Catheterization and PCI

- Who should undergo such?
- When should it be done?
- Does it Improve Outcome?



## Spaulding et al.

- 1994-1996
- 1762 patients with OOH CA
  - 910 had resuscitation efforts attempted
    - 312 were resuscitated in the field
    - 126/312 died in route to hospital
    - 102/312 were excluded for non-cardiac causes of their CA
    - 84/312 were taken to cath lab after successful resuscitation
- 60/84 (71%) had clinically significant CAD
- 40/84 (48%) had total occlusions
  - 37/84 (44%) had PCI attempted
    - 28/37 (76%) were successful
- In-hospital survivor rate was 38%

NEJM 1997;336:1629

## Spaulding et al.

“Clinical and electrocardiographic findings, such as chest pain and or ST elevation on the ECG were poor predictors of acute coronary occlusion.”

NEJM 1997;336:1629

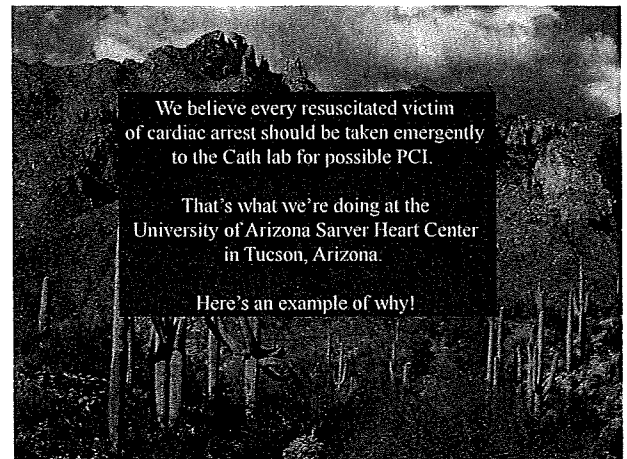
## Immediate Coronary Angiography Post Resuscitation

- Resuscitated patients with STEMI on ECG
  - Yes!
- Resuscitated patients without STEMI on ECG
  - Yes/No? → Less certain but Probably

• Can't always tell by 12 lead ECG post resuscitation who has an occluded coronary vessel!

## Coronary Intervention for STEMI: Post Resuscitation ?

- 13 clinical series have been reported in the recent era
  - N = 744 patients
    - 462/744 (62%) survived to hospital discharge
    - 308/376 (82%) of survivors had good neuro fx



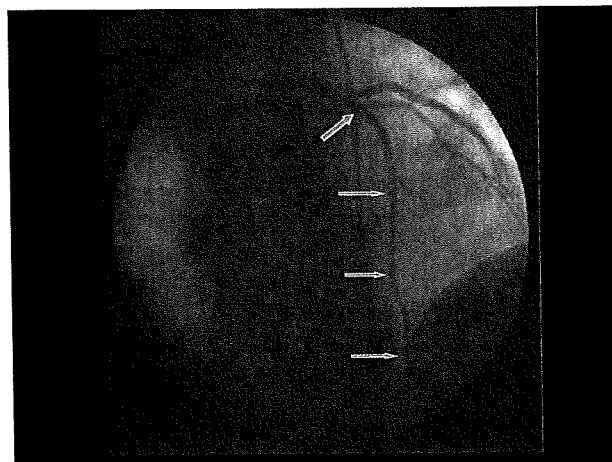
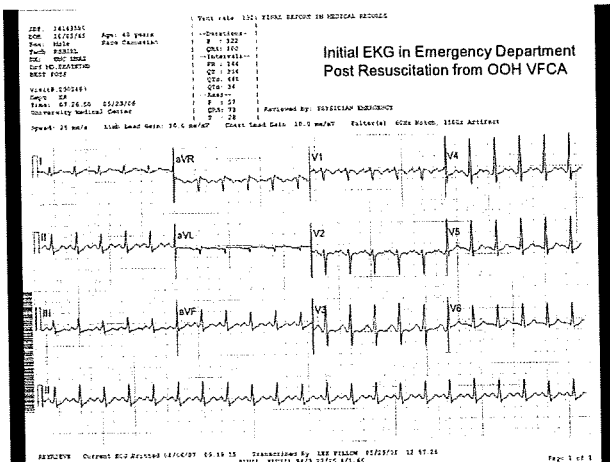
## Combined Therapeutic Hypothermia and Coronary Intervention Post Resuscitation

- 3 clinical reports now
  - N = 106 patients
    - 483/106 (78%) survived to hospital discharge
    - 67/83 (81%) of survivors had good neuro fx

## ▫ 40 yr old male

- Athletic swimmer collapsed in shower post work out
- Chest compression only BLS immediately
- AED brought w/i 5 min and 2 shocks given
- Pulse present on EMS arrival, but comatose

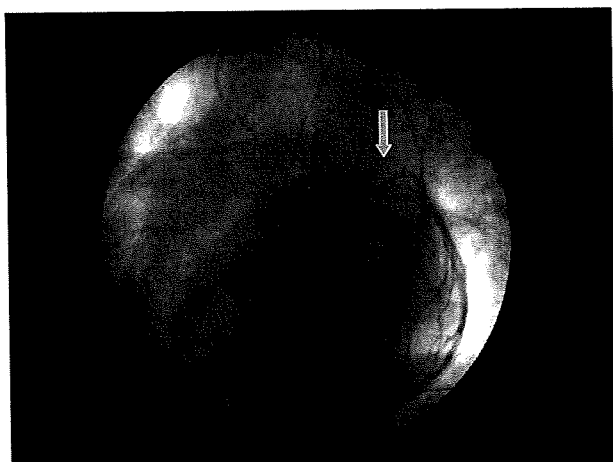




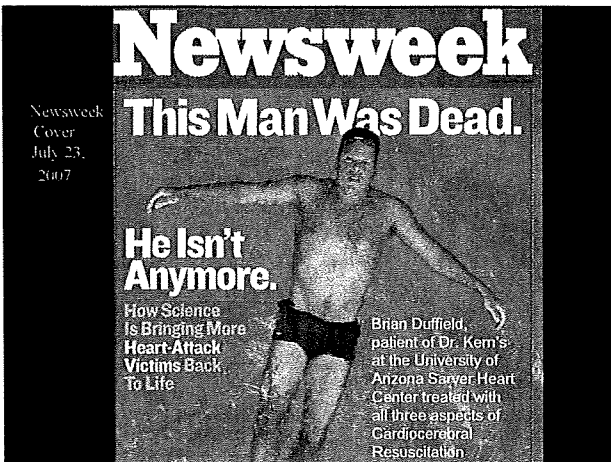
## Immediate Angiography/PCI or NOT ?

- ┆ Stat ED echocardiographic exam: decreased anterior wall motion
- ┆ Decision was then made to take to the CCL
- ┆ Mild therapeutic hypothermia started while in the ED

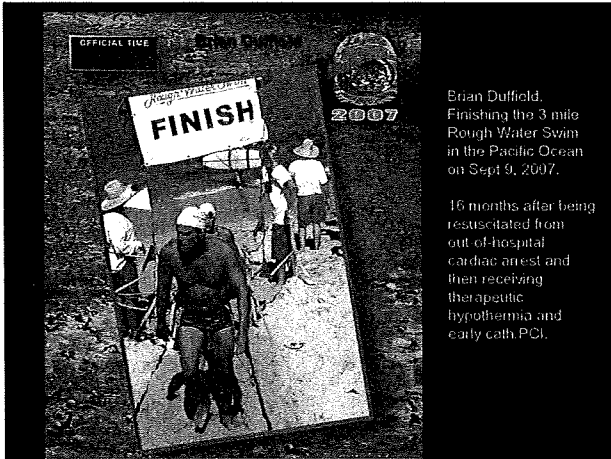
- ┆ Echo after PCI: LVEF = 20%
- ┆ Warmed up after 24 hours
- ┆ COMPLETELY NORMAL CNS Function
- ┆ Discharged 5 days later
- ┆ Business trip the following week



- ┆ Repeat Echo 6 weeks later:
- ┆ LVEF = 50% with minimal septal hypokinesis



Aggressive Post Resuscitation Care  
is the 3<sup>rd</sup> Pillar of  
Cardiocerebral Resuscitation

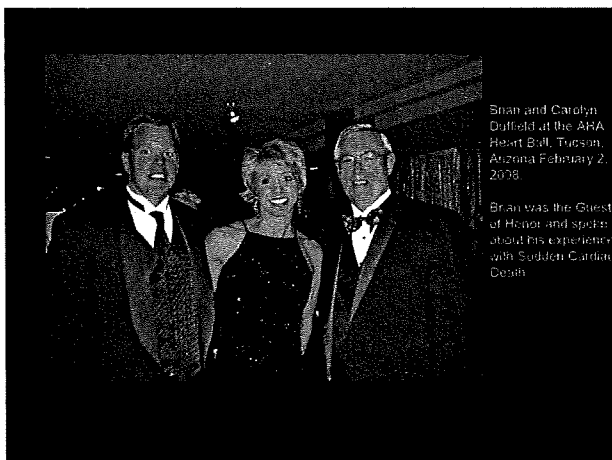


What Can the Survival Rates Be with All  
Three Pillars of CCR ???

Doubling of the survival rates achieved with the first two pillars:

All rhythms:  
7% to ~15% ?

Witnessed Ventricular Fibrillation:  
25% to ~50% ?



**MORE**  
**CCR Saves Lives!**

THE UNIVERSITY OF  
**ARIZONA**  
SARVER HEART CENTER

Cardiocerebral Resuscitation Really Does  
Saves More Lives !!

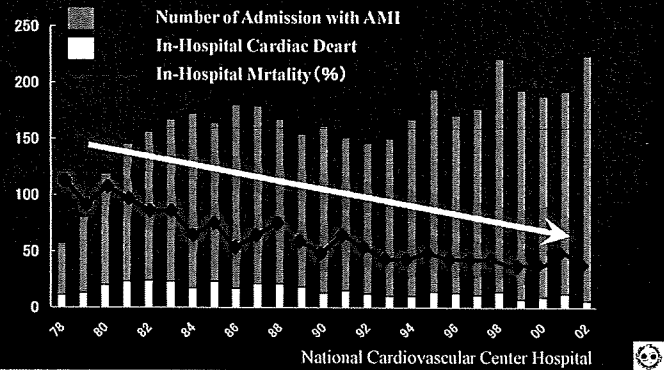
Another Opportunity to  
Improve ...

# Mobile Telemedicine -A Future Direction in Cardiac Emergency-

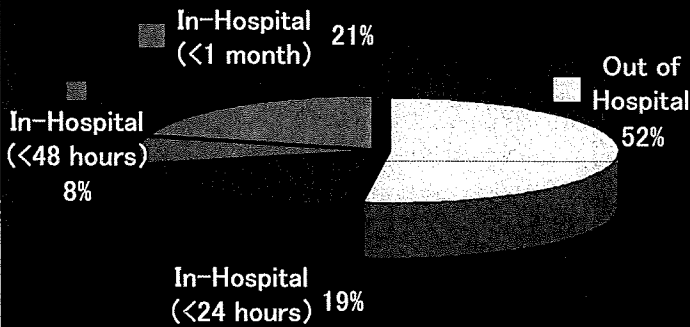


Hiroyuki YOKOYAMA, Hiroshi NONOGI  
Division of Cardiology & Emergency Medicine  
National Cardiovascular Center

# In-Hospital Mortality of AMI; NCVC



# Mortality of AMI



American Heart Association and GUSTO-I Investigators,  
Circulation, 1994;90

## 循環器疾患の急性期に何が生じる？ What will happen in acute phase of cardiac emergency ?

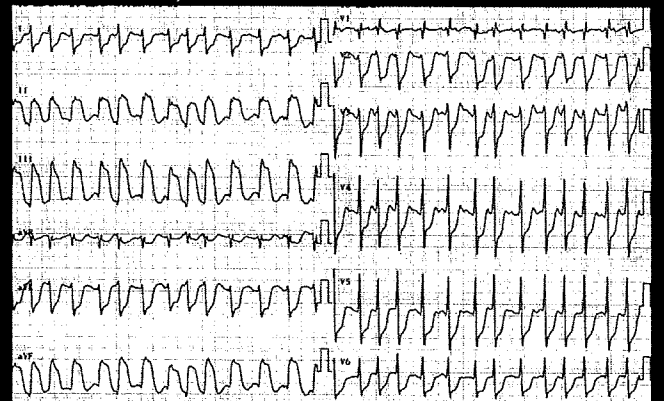
- 急性心筋梗塞：AMI
- 急性大動脈解離：Aortic Dissection
- 急性肺血栓塞栓症：PTE
- 急性心不全で心停止：ADHF

# A Case ; AMI who showed VF at ER ECG at Home recorded by Doctor Car



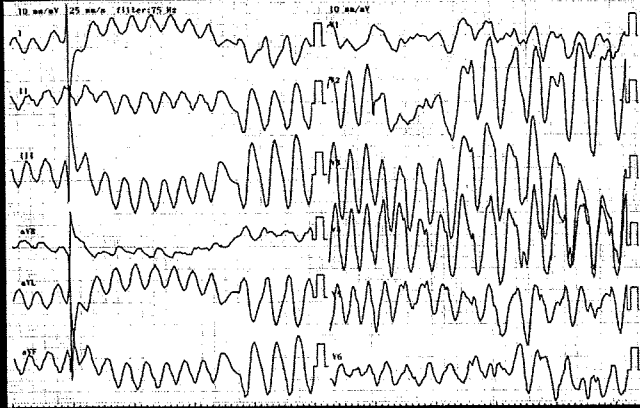
II, III, aVf; ST ↓  
AF, HR 100~130/min, ICRBBB

# A Case ; AMI who showed VF at ER



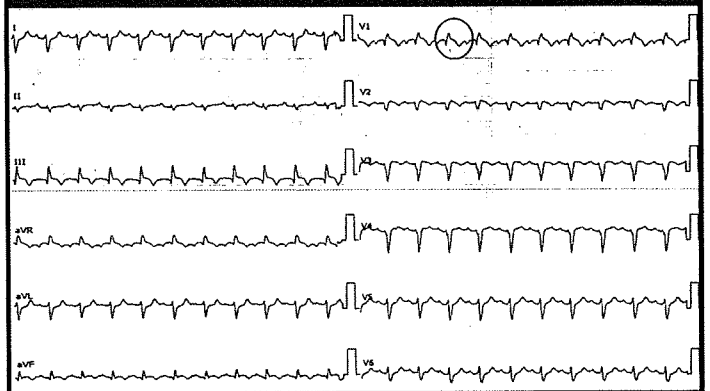
Arrived on ER; II, III, aVf ST ↓ ↓ ↓

### A Case ; AMI who showed VF at ER



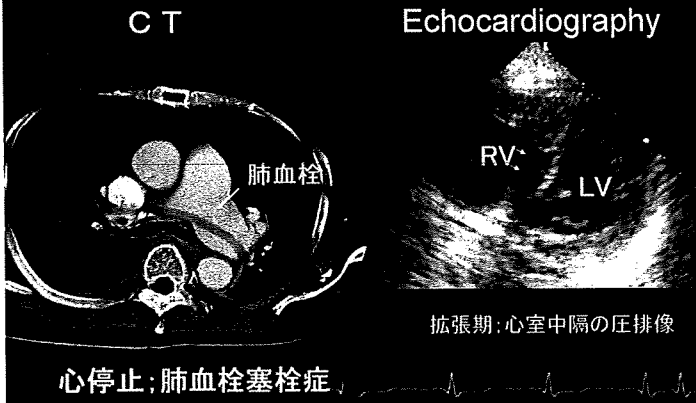
5 min after Arrived on ER; VF

### A Case; PTE who showed CPA at ER

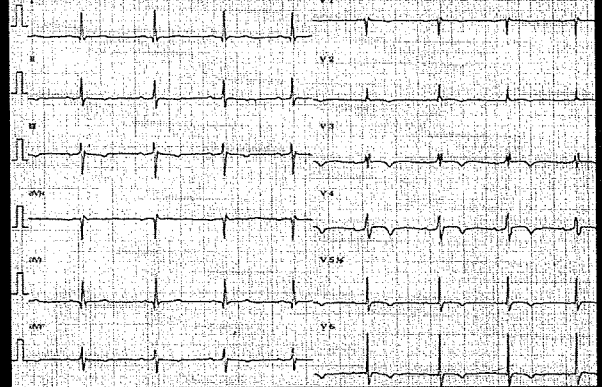


緊急外来で無脈性電氣的興奮へ移行

### A Case; PTE who showed CPA at ER

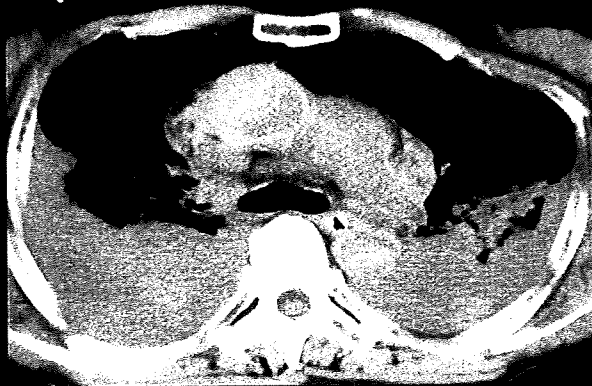


### Aortic Dissection who showed CPA during EMS



搬送途中で無脈性電氣的興奮へ移行

### Aortic Dissection who showed CPA during EMS



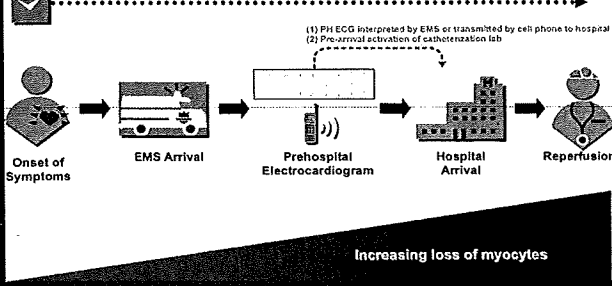
搬送途中で無脈性電氣的興奮へ移行

## Background

- AHA/ACC guidelines recommend routine use of 12-lead ECG and advance notification to the receiving facility speed diagnosis, shorten time to reperfusion therapy for patients with acute coronary syndrome.
- However, transmission of out-of-hospital 12-lead ECG to emergency department is still not spread and ECG interpretation on the prehospital and emergency department is not established.

## Reperfusion time goals for patients with ST-segment-elevation myocardial infarction

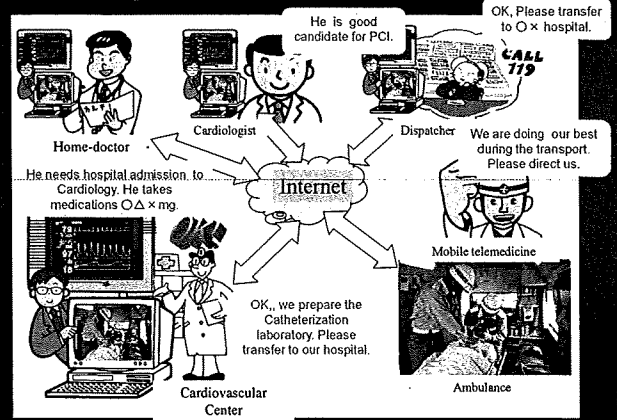
Reperfusion goals: EMS-to-drug < 30 min; EMS-to-balloon < 90 min; Symptom onset-to-reperfusion < 120 min (text adapted from reference 1)



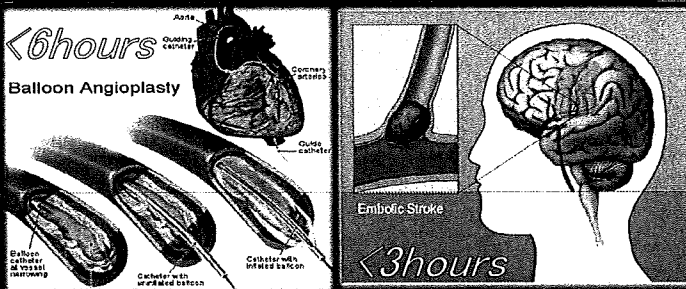
Implementation and Integration of Pre-hospital ECGs Into Systems of Care for Acute Coronary Syndrome  
A Scientific Statement From the American Heart Association  
Interdisciplinary Council on Quality of Care and Outcomes Research, Emergency Cardiovascular Care Committee, Council on Cardiovascular Nursing, and Council on Clinical Cardiology

Ting, H. H. et al. Circulation 2008;118:1066-1079

## Concept of Mobile telemedicine



## Concept of Mobile telemedicine



AMI

Stroke

Emergency Medical Care

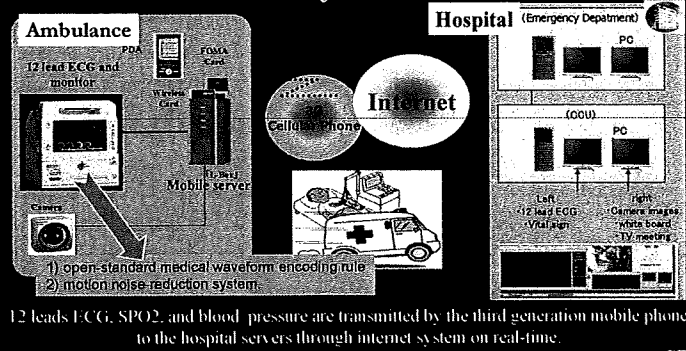
Remote Communication & Consultation

## PURPOSE

We have developed and tested the clinical usefulness of the mobile telemedicine system transmitting 12-lead ECG and other parameters between moving ambulances and physicians in cardiovascular emergency to improve pre-hospital care of cardiovascular emergency.

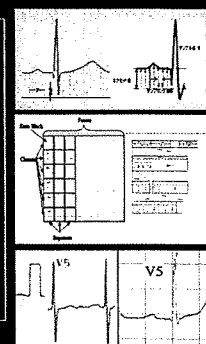
## Method

### 1. system



### 2. Method for standardized Encoding Medical Waveform Format Encoding Rule (MFER)

- Flexible
  - ECG, EEG, BP, SpO2, etc
- Simple
  - vs HL7, vs DICOM
  - vs IEEE 1073 (ISO11073)
- Open
  - Specs
  - Source Codes
- Standard
  - Future ISO
- Free
  - <http://ecg.heart.or.jp/En/Index.htm>

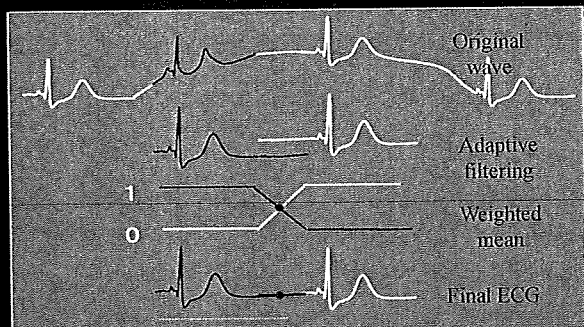


Sampling

Describe and display

JPEG (12 LEAD : 90KB) MFER (12 LEAD : 79KB)

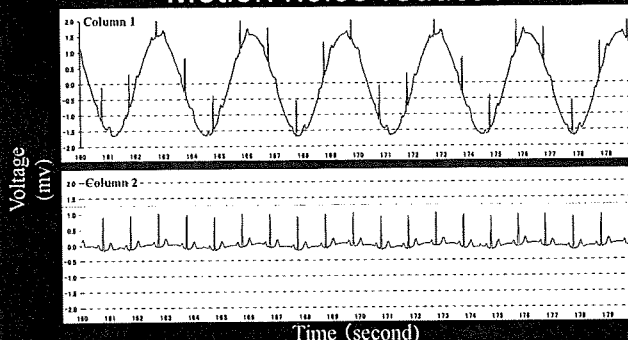
### 3. Motion noise-reduction: filter and weighted mean



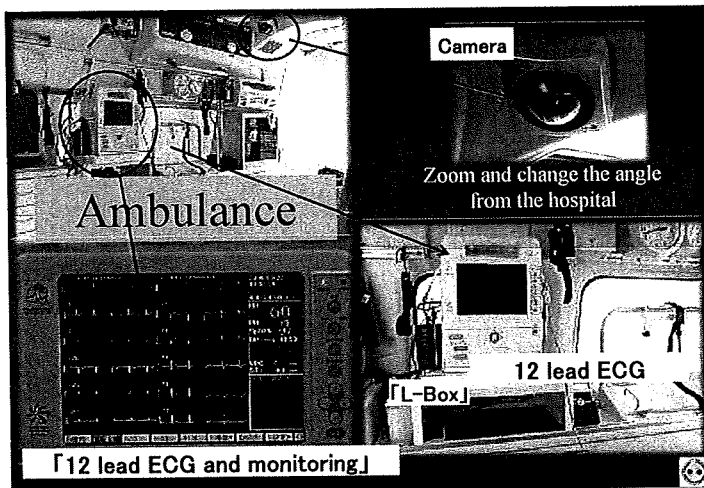
Each adaptive filter is used in every beats. Each filtered ECG is connected smoothly at the red point by weighted mean method. At final ECG, the ECG wave with yellow line is distorted rather than the other ECG wave.



### Motion noise-reduction



The column 1 shows the original ECG wave. The column 2 shows the filtered ECG wave with the adapted filtering and weighted mean method.



### Field-test

- Real time 12-lead ECG was transferred together with vital signs and live video during transfer a volunteer by an ambulance.
- We checked the performance and time-delay of the mobile telemedicine system to transfer the data including 12-lead ECG, monitor ECG, BP, HR, oxygen saturation and live video.
- Transferred 12-lead ECGs were compared with those original one in the ambulance in different scenarios such as a moving hand or leg, coughing or twisting body in an ambulance driving on common road or highway in Suita city



Common road



Highway



### Assessment for 12 lead ECG recordings

During common road or highway driving (30 scenarios)

1. Rest
2. Hyperventilation
3. Sitting
4. Muscle strength
5. Twist
6. Tapping the chest
7. Decubitus
8. Yawning
9. Cough
10. Leg elevation
11. Touch by another person
12. Shaking ECG Lead
13. VPC
14. ST elevation
15. With or without Hum filter

During highway (3 scenarios)

1. 80km/h speed
2. 105km/h speed
3. Into a tunnel

During Parking with or without hum filter (3 scenarios)

1. Rest
2. Leg elevation
3. Twist

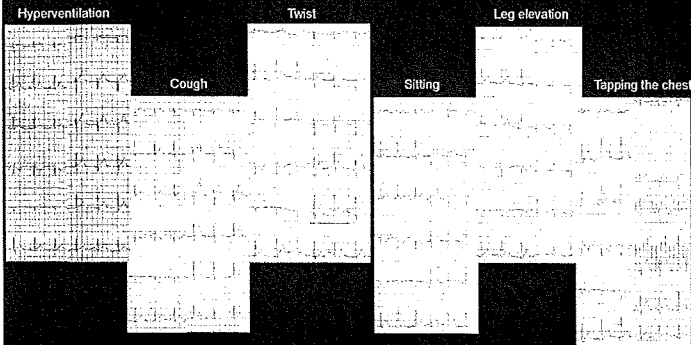


### Field-test results

1. Totally 36 patters of 12-lead ECG were checked in the field test. All of them were comparable to those original one in the ambulance during driving in the common road and highway. Recording and interpretation of ECG are possible during a moving hand or leg, coughing or twisting body during transport.
2. Time-delay for transmission of 12 lead ECG was within 10seconds and for one-lead ECG monitoring and vital signs including BP, HR and oxygen saturation was 1 second without the difficulties for the interpretation.



## Motion noise in ECG recording



Motion noise reduction filter is effective in almost situations except chest leads during tapping the chest.

## For the clinical condition

•We set up using the third-generation (3G) digital mobile phone to promote communications between moving 5 ambulances in Suita-city and National Cardiovascular Center since 2008 June 2.

•To establish the efficacy of real-time transmission of out-of-hospital 12-lead ECG, time-line from the onset of acute myocardial infarction to reperfusion will be analyzed in ongoing study.

### Mobile telemedicine between ED and Ambulance

12-lead ECG  
Vital signs: HR, BP, SpO<sub>2</sub>

Patient live-video communication with CCU

### Mobile telemedicine between 5 ambulances in Suita-city and National Cardiovascular Center

Transportation time to tertiary hospital in Suita-city and National Cardiovascular Center

Suita city  
Area: 36km<sup>2</sup>  
population 353,100

Dispatch Center  
5 Fire department

Japan

Legend for transportation time to tertiary hospital:

- <15min
- 16min-30min
- 31min-60min
- 61min-90min
- 91min-120min
- >120min
- Not analyzed

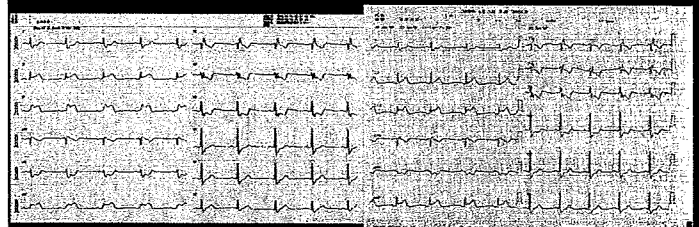
## Representative Case: STEMI

2:25	Call 911(119 in Japan) due to resting chest pain	
2:31	EMS Arrival	
2:40	Activate ED	
2:42	Using Mobile telemedicine(12 lead ECG,HR•SaO <sub>2</sub> •BP, live video)	
2:42	ST elevation was diagnosed by physician →Activate Cath Lab and staff	
2:42	Information from mobile telemedicine	
	Live video: consciousness clear without orthopnea	
	HR 50 bpm, BP 132/72 mmHg	
	SaO <sub>2</sub> 100% (Oxygenation 10L/min with Mask )	
2:46	Transport to hospital with continuous monitoring using mobile telemedicine	
3:00	Hospital Arrival	
3:03	Recognizing STEMI and informed consent	D2B time 52 min
3:05	Evaluation in ED including echocardiography	
3:20	CathLab	
3:52	Success in reperfusion with PCI	

## Representative Case: STEMI

12 lead ECG using mobile telemedicine

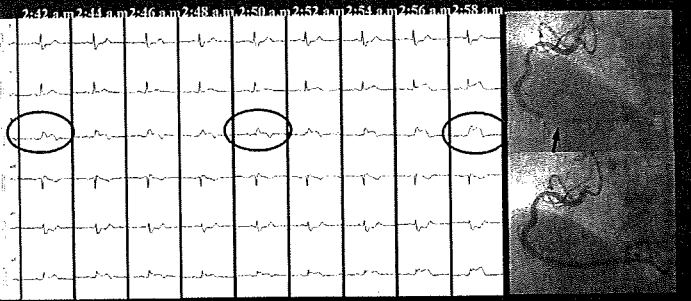
12 Lead ECG on ED arrival (Analog)





**Continuous 12 lead ECG monitoring during transport by ambulance**

CAG and PCI



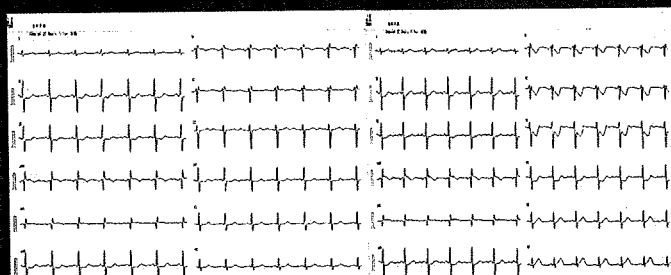
stenting to right coronary artery

**Case 2. Worsening ST depression during transport**

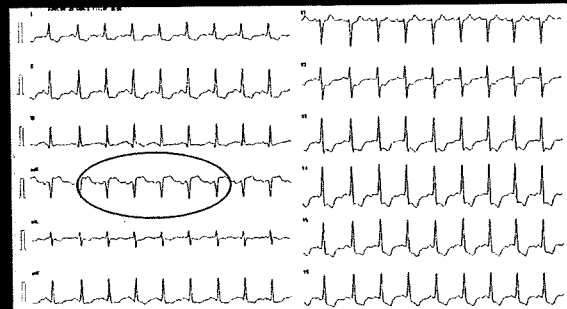
- 10:40 Call 911 due to chest pain at rest
- 12:08 Activate hospital
- 12:08 mobile telemedicine with 12 lead ECG,HR•SaO2•BP, and live video
- 12:08 12 lead ECG shows mild ST depression
- 12:10 live video: consciousness clear with normal breath
- 12:15 ST depression worsening→call staff
- 12:20 informed consent from patient and family through mobile telephone
- 12:30 ED arrival
- 12:30 recognized NSTEMI
- 12:35 echocardiography and examinations
- 12:50 cathlabo
- 13:17 emergency PCI

D2B time  
47 min

**Case 2. Worsening ST depression during transport**



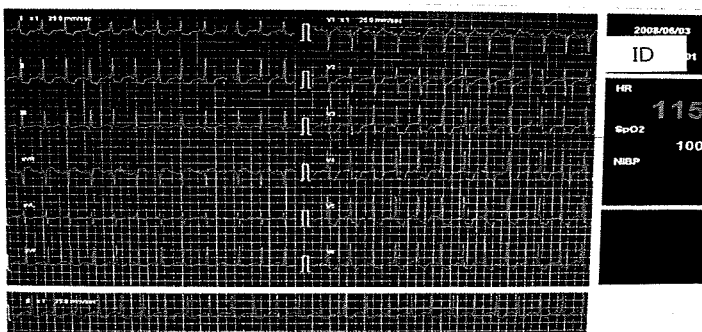
**Case 3. AMI with left main coronary artery disease**



Using Mobile telemedicine with aVR ST elevation and extensive ST depressions, CCU physician suspected AMI with LMCA disease and activated cathlabo for emergency CAG during transport to hospital.

**Case 3. AMI with left main coronary artery disease**

**Real Time 12 Leads ECG**



**CONCLUSION**

Those results indicate the usefulness and reliability of transmission of 12-lead ECG using the mobile telemedicine system from the ambulance.

Further investigation is ongoing to determine the efficacy in clinical conditions to reduce the treatment delay for acute myocardial infarction comparing with data before setup of the mobile telemedicine system and those from other EMS without the mobile telemedicine system.

# 大規模データベース活用の誘いと 国際発信・海外派遣報告会

日時 平成22年3月18日午後7時～8時

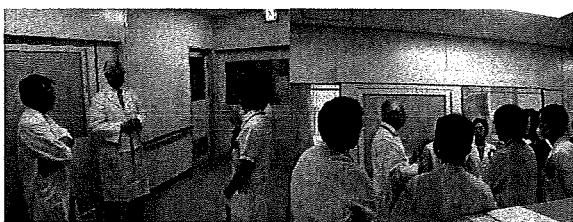
場所 国立循環器病センター第4会議室

現在、循環器救急関連の多施設共同研究や登録で海外発信が実施され、多くの成果が報告されています。当施設が主任で実施している研究もあり、若手研究者の参画が可能です。海外との連携も積極的に実施され、その関連で、3年目レジデントがアリゾナ大学、あるいは共同研究者がシアトルへ短期留学をしています。

是非、センターのスタッフやレジデントにその内容を伝え、今後の成果発信や海外連携を活かしてもらいたいと考えています。

皆さんが利用できるデータベースについてお話しし、また3レジ篠岡先生と東先生のアリゾナ大学留学体験を披露してもらいますので、ご関心のある皆様方に広くご参集いただければ幸いです。

国立循環器病センター  
心臓血管内科 野々木 宏 、横山 広行



# 研究実績報告書

## 1. 派遣研究者

所属・職名：国立循環器病センター 心臓血管内科 レジデント  
氏名：篠岡 太郎、 東 晴彦

## 2. 派遣先および研究指導者

国名：アメリカ合衆国  
所在地：アリゾナ州、ツーソン市  
名称：アリゾナ大学、サーバーハートセンター  
職名：医学部教授（循環器部門）  
氏名：Karl B. Kern

## 3. 主任研究者

所属・職名：国立循環器病センター 心臓血管内科部長  
氏名：野々木 宏

## 4. 派遣期間

平成 21 年 10 月 1 日～平成 21 年 12 月 31 日 92 日間

## 5. 研究課題

蘇生後心筋保護における低体温療法・再灌流療法、薬物(ニコランジル・hANP)  
投与の効果に関する研究

## 6. 研究活動の概要

<アリゾナ大学について>

アリゾナ大学はアメリカ南西部のアリゾナ州第2の都市であるツーソン市に位置する総合大学であり、その創設は1885年とアリゾナ州最古の大学として知られている。人口60万人のツーソンにおいて、1.5km<sup>2</sup>の広大な敷地に約3万人の学生を擁しており、アリゾナ大学の街といっても過言ではない。

大学付属病院(University Medical Center : UMC)は厳密的には大学からは独立した組織となっており、私立病院の範疇に入れられてはいるものの、州唯一のアリゾナ大学医学部を併設しており、実際には大学組織の一部として機能している。地域の中

核を担う急性期病院で、ベッド数は399ベッドと日本の総合病院などと比較すると少ないものの在院日数の短い米国においては比較的大規模な病院である。派遣受け入れ機関の Sarver Heart Center (SHC) は UMC 内の循環器領域研究部門であり、UMC に隣接して6層建ての独立した建物を占有している。同センターは所長の Gordon Ewy 教授を筆頭に、心臓内科・心臓外科の臨床・研究が積極的に展開されており、さまざまな成果を上げている。

#### <Sarver Heart Center (SHC) CPR グループについて>

今回は Sarver Heart Center 内、CPR(蘇生)グループにて研究を行った。CPR グループは Karl B. Kern 教授を中心としたグループであり、UMC 内の麻酔科・代謝内科の研究者とも密接な連携をとり、研究に取り組んでいる。同グループは全米でも屈指の蘇生領域の研究グループとして知られており、現在までに無数の新たな知見を発信している。

1980年代より、CPR グループはブタを中心とした大型哺乳類での蘇生に関する研究を開始しており、カテコラミン投与が蘇生後短期間の予後を改善するなどの重要な報告を行っている以外にも1990年代初頭には蘇生手技・方法についても多くの報告を行っている。特に、蘇生手技に人工呼吸が必要かどうかの議論においては、蘇生には冠灌流圧が最も重要であるとのデータを動物実験にて提示し、アリゾナ州においては院外心停止症例では胸部圧迫を持続的に行う心脳蘇生法(Cardioverebal resuscitation)の実施が救急隊員に徹底され、救命率の向上が証明されるなど、その研究結果は臨床応用に至っている。

#### <派遣までの経緯・準備等について>

我々は集中治療部での研修等における臨床医学での経験から、心肺停止患者において、心肺蘇生にて幸いにも自己心拍が再開したにも関わらず、蘇生後の低心機能により救命でいかなかった症例を経験し、そのメカニズムについて興味を抱いていた。前述の通り、強心薬の投与により蘇生後急性期の救命率の上昇は示されていたが、重症心不全においては強心薬が予後を不良の一因子になりえるとのエビデンスも確立されており、強心薬のみの投与のみでは蘇生後低心機能を予防できず、長期的な救命率の向上にはつながらないのではないかと考えた。その中で、心保護薬として日本では心不全に対して頻用されるようになったカルペリチドや、Pre conditioning 効果があるとされているニコランジルが蘇生後低心機能の予防効果を持ち得るのではないかと推測した。これらの薬剤が蘇生後に良好な転帰を来たすかどうかなどを研究した報告は非常に稀であり、ラットなどで検討した例はあるものの、臨床応用できるにはほど遠く十分な知見があるとは言い難い状況であった。

そのような状況の中、2008年12月に当該研究による外国人研究者招聘事業により SHC の Kern 教授が来日され、国立循環器病センターにて共同研究に関する意見交換や講演が催された。講演後には、研究代表者である野々木部長と共に蘇生後低心機能についてディスカッションをする機会があり、これらの薬剤の有用性などについても深く議論を行った。その議論の中で、日本ではなかなか行う事が困難である大型哺乳類