

# **STEMI Transfer: Wheels or Blades**

## **Insight from the Copenhagen PCI Center**

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# Potential conflicts of interest

**Peter Clemmensen**

**I have the following** potential conflicts of interest to report:

Research contracts

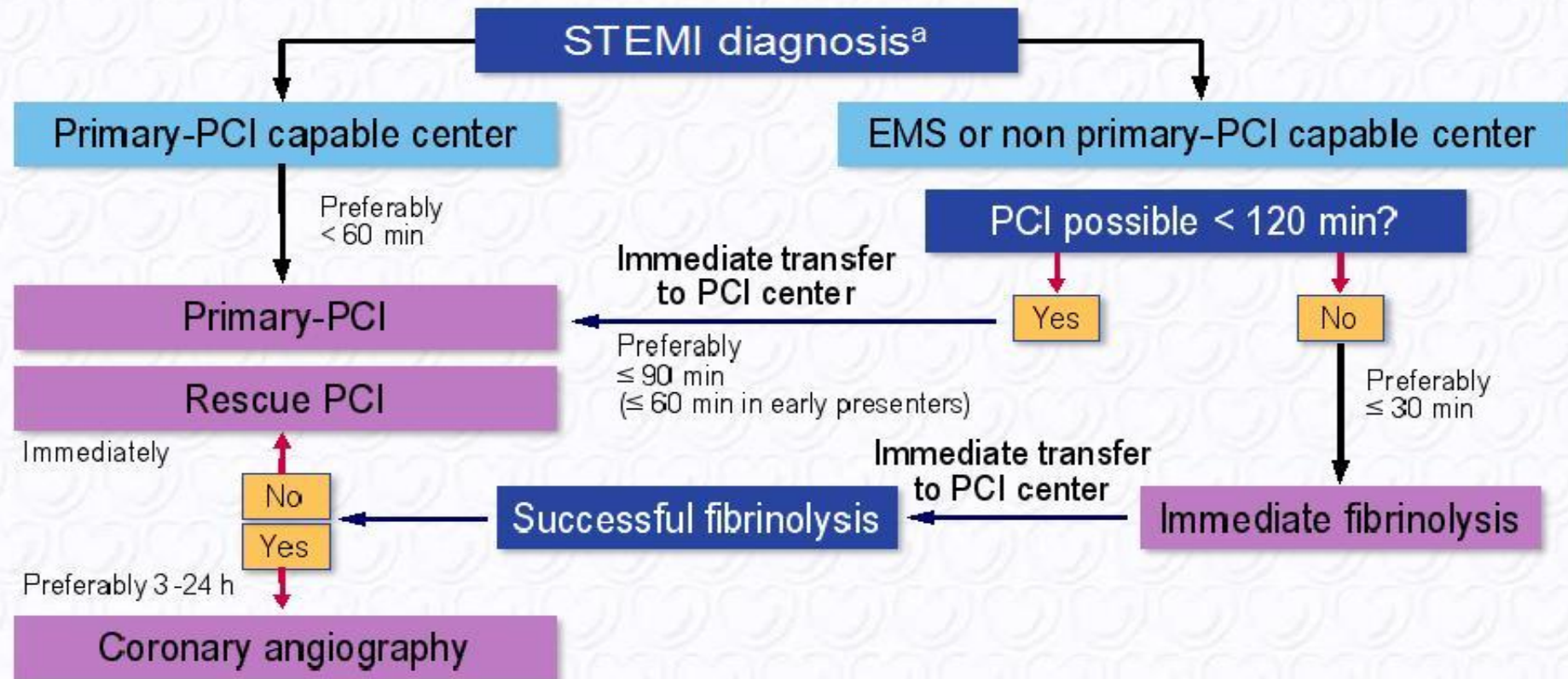
Consulting

Abbott, Acarix, AstraZeneca, Aventis, Bayer, Boeringer  
Ingelheim, Bristol Myers Squibb, Daiichi Sankyo, Eli-Lilly, Merck,  
Myogen, Medtronic, Mitsubishi Pharma, Nycomed, Organon, Pfizer,  
Pharmacia, Sanofi-Aventis, Sanofi-Synthelabo, Searle, The  
Medicines Company.

# Challenges and Guidelines

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# Prehospital and in-hospital management, and reperfusion strategies within 24 h of FMC



<sup>a</sup> The time point the diagnosis is confirmed with patient history and ECG ideally within 10 min from the first medical contact (FMC). All delays are related to FMC (first medical contact).

Cath = catheterization laboratory; EMS = emergency medical system; FMC = first medical contact; PCI = percutaneous coronary intervention; STEMI = ST-segment elevation myocardial infarction.

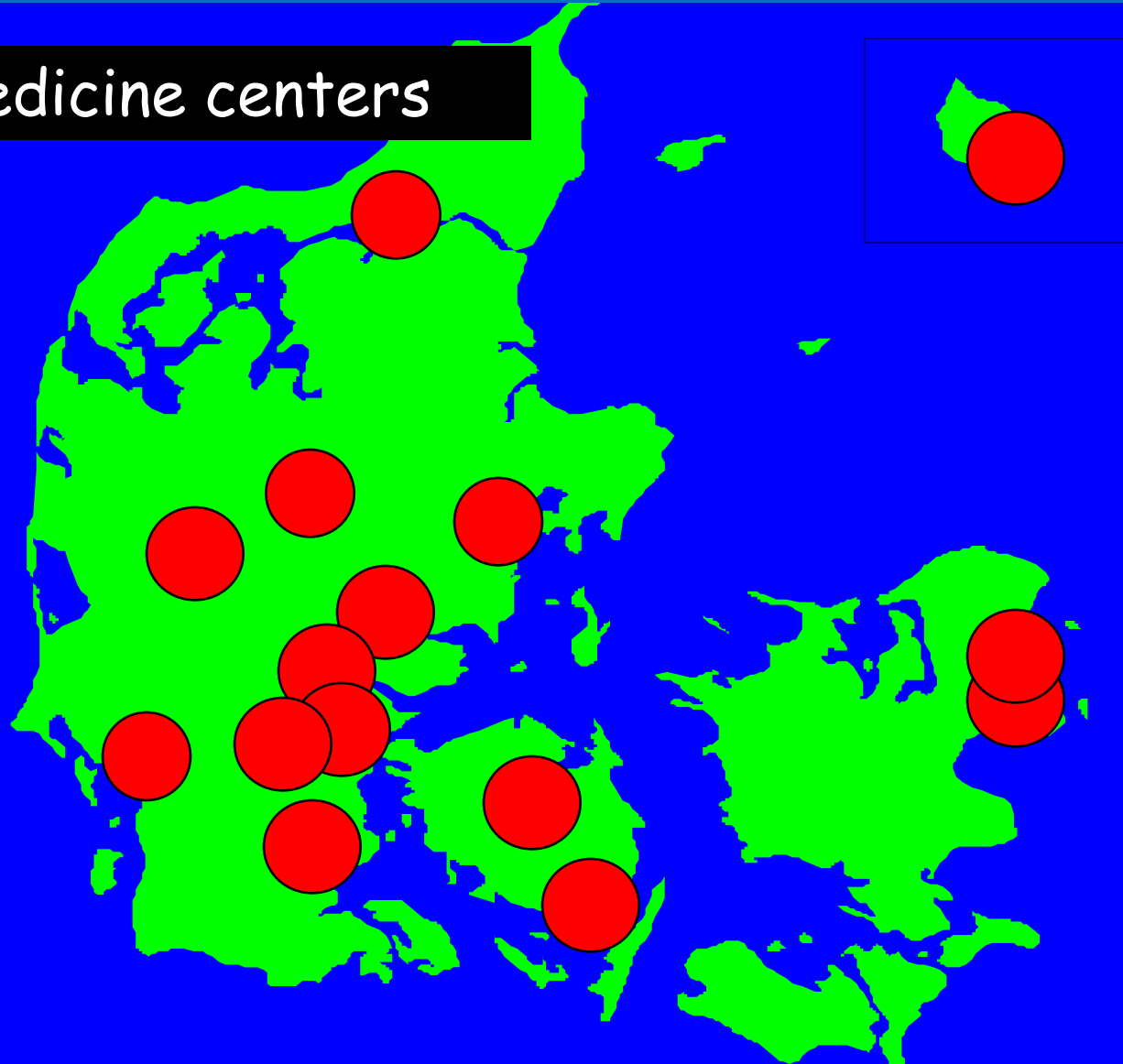
# The Danish Solutions

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**STEMI networks**  
**Prehospital Triage**

# Background:

15 Telemedicine centers



450 ambulance vehicles transmit ECGs

# Implementation of reperfusion therapy

## Danish law since 2008

### Ambulances

- |                    |      |
|--------------------|------|
| • Defibrillators   | 100% |
| • 12 lead ECG      | 100% |
| • ECG Transmission | 100% |





# Paper vs. Fax vs. LCD





# Pre-hospital diagnosis & triage by tele-ECG



12 lead EKG  
LIFEPAK 12/15  
Medtronic



Attending Cardiologist

| Oct.2003-<br>Oct. 2005 | Referred<br>patients<br>n=146 | DANAMI-2<br>controls<br>n=89 | p value |
|------------------------|-------------------------------|------------------------------|---------|
| Door-to-PCI            | 34 (19-46)                    | 97 (80-124)                  | <0.001  |

$\Delta=63$  minutes

# The Danish Solutions

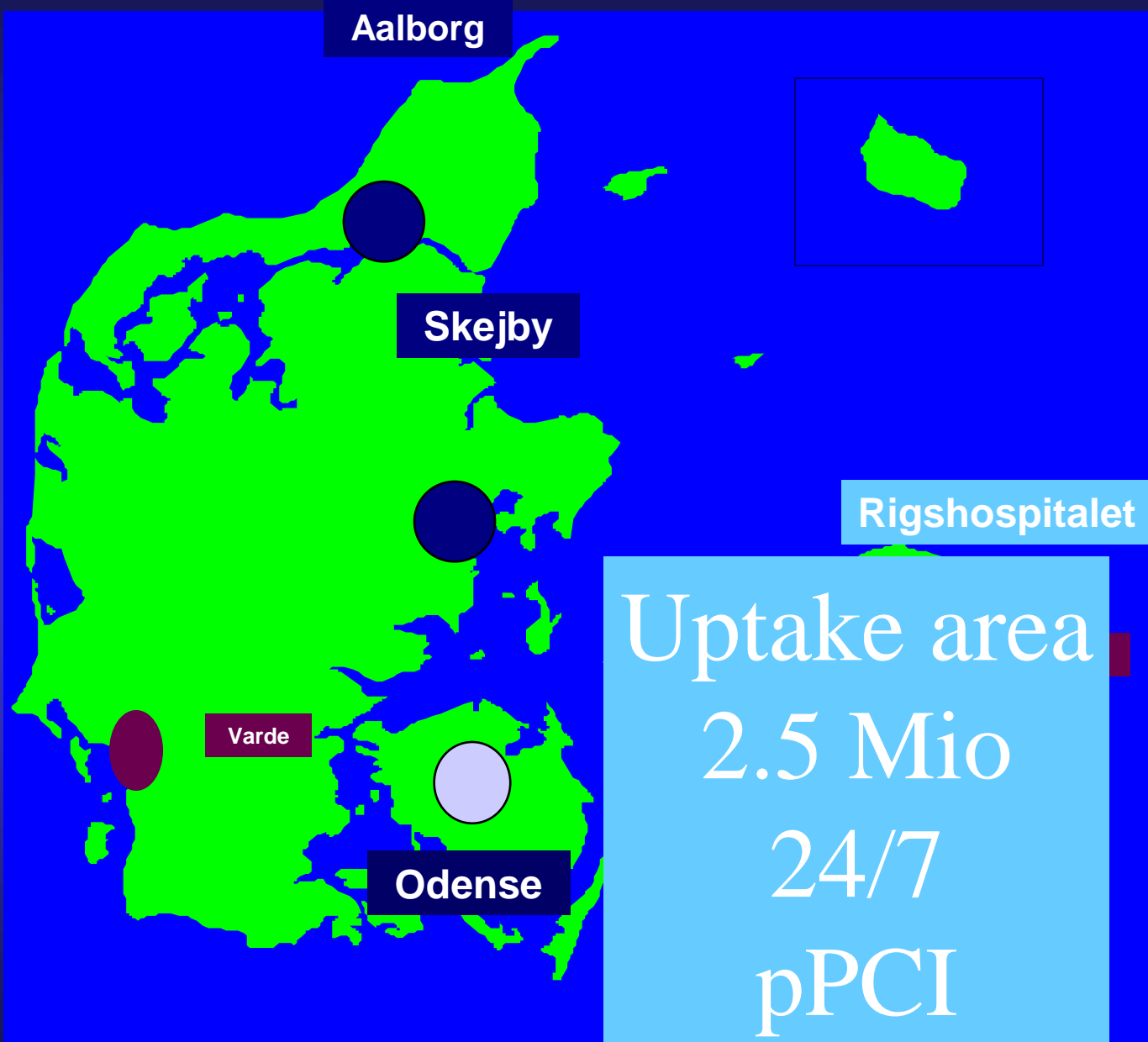
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**Real World Data**

**University of Copenhagen  
PCI Center**

# Denmark 5.5 M Inhabitants

2010  
Politicians  
Closed  
1/5  
pPCI  
Center



# Treatment delays when doubling the cathment area for pPCI in STEMI

|                                  | 1/6-2010 - 31/5-2011<br>(n = 472) | 1/6-2011 - 31/5-2012<br>(n = 936) |       |
|----------------------------------|-----------------------------------|-----------------------------------|-------|
|                                  |                                   |                                   | ↑ 98% |
| Symptom to ECG                   | 75 (40-158)                       | 76 (42-155)                       | →     |
| Transport delay (ECG to arrival) | 75 (47-105)                       | 59 (38-89)                        | ↓ 21% |
| Door-to-balloon                  | 23 (18-33)                        | 23 (19-30)                        | →     |
| Symptom to balloon               | 196 (137-304)                     | 175 (125-270)                     | ↓ 11% |
| ECG to balloon                   | 101 (77-134)                      | 85 (64-115)                       | ↓ 16% |

*Median minutes (interquartile range)*

Telemedicine triage of STEMI 1/6-2011 - 31/5-2012: 68%

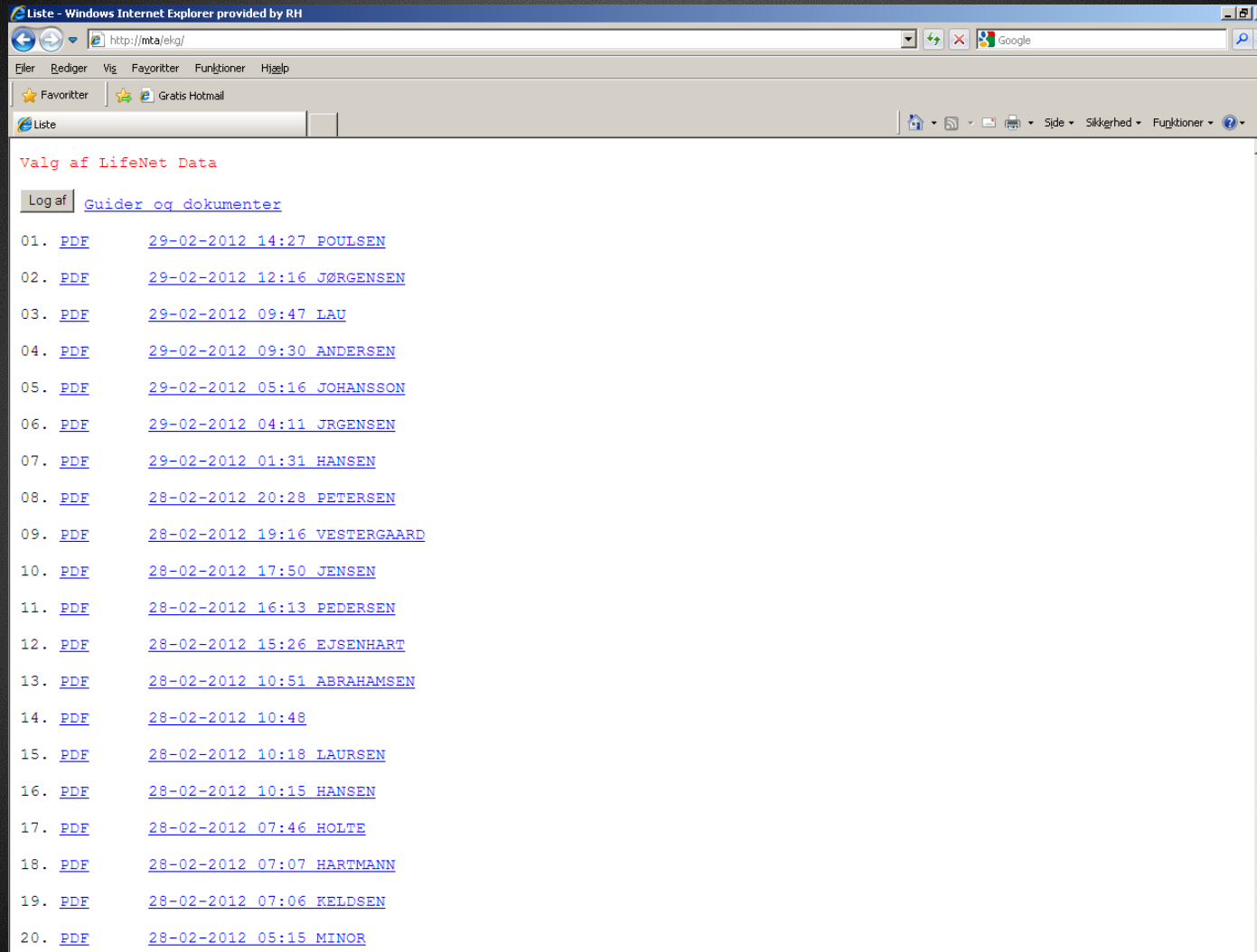




# Centralized Heart Station



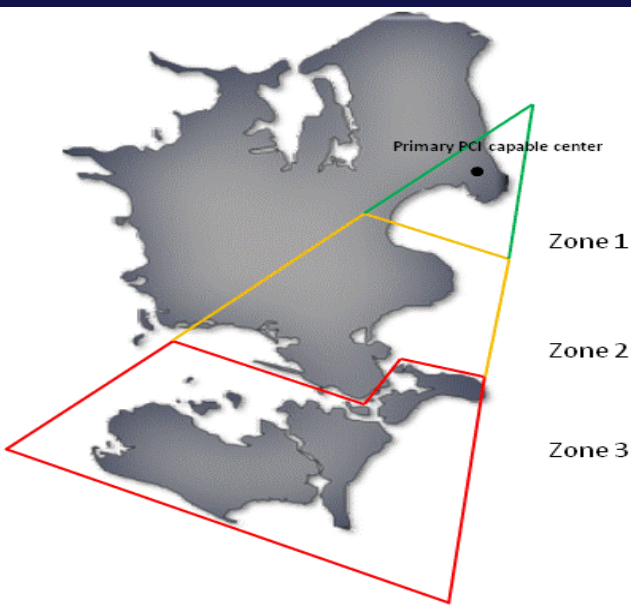
# Teletransmitted ECG's visible on *all* Hospital Computers



The screenshot shows a Windows Internet Explorer browser window with the address bar set to <http://mta/ekg/>. The page title is "Liste - Windows Internet Explorer provided by RH". The main content area displays "Valg af LifeNet Data" and a "Log af" button. Below this is a list of 20 items, each consisting of a number, a PDF icon, a timestamp, and a name. The list is as follows:

| Item | PDF                 | Timestamp        | Name        |
|------|---------------------|------------------|-------------|
| 01.  | <a href="#">PDF</a> | 29-02-2012 14:27 | POULSEN     |
| 02.  | <a href="#">PDF</a> | 29-02-2012 12:16 | JØRGENSEN   |
| 03.  | <a href="#">PDF</a> | 29-02-2012 09:47 | LAU         |
| 04.  | <a href="#">PDF</a> | 29-02-2012 09:30 | ANDERSEN    |
| 05.  | <a href="#">PDF</a> | 29-02-2012 05:16 | JOHANSSON   |
| 06.  | <a href="#">PDF</a> | 29-02-2012 04:11 | JRGENSEN    |
| 07.  | <a href="#">PDF</a> | 29-02-2012 01:31 | HANSEN      |
| 08.  | <a href="#">PDF</a> | 28-02-2012 20:28 | PETERSEN    |
| 09.  | <a href="#">PDF</a> | 28-02-2012 19:16 | VESTERGAARD |
| 10.  | <a href="#">PDF</a> | 28-02-2012 17:50 | JENSEN      |
| 11.  | <a href="#">PDF</a> | 28-02-2012 16:13 | PEDERSEN    |
| 12.  | <a href="#">PDF</a> | 28-02-2012 15:26 | EJSENHART   |
| 13.  | <a href="#">PDF</a> | 28-02-2012 10:51 | ABRAHAMSEN  |
| 14.  | <a href="#">PDF</a> | 28-02-2012 10:48 |             |
| 15.  | <a href="#">PDF</a> | 28-02-2012 10:18 | LAURSEN     |
| 16.  | <a href="#">PDF</a> | 28-02-2012 10:15 | HANSEN      |
| 17.  | <a href="#">PDF</a> | 28-02-2012 07:46 | HOLTE       |
| 18.  | <a href="#">PDF</a> | 28-02-2012 07:07 | HARTMANN    |
| 19.  | <a href="#">PDF</a> | 28-02-2012 07:06 | KELDSSEN    |
| 20.  | <a href="#">PDF</a> | 28-02-2012 05:15 | MINOR       |

# Results: Reperfusion delays



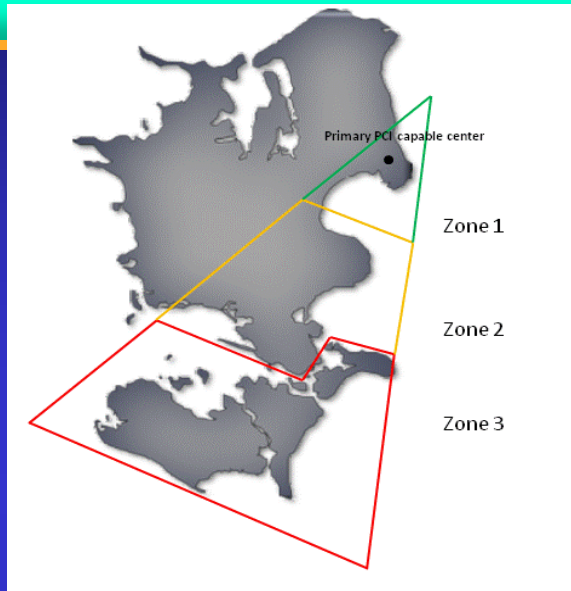
## Median time intervals in minutes

|                     | <b>Zone 1<br/>(0-25 km)</b> | <b>Zone 2<br/>(65-100 km)</b> | <b>Zone 3<br/>(100-185 km)</b> | <b>P value</b> |
|---------------------|-----------------------------|-------------------------------|--------------------------------|----------------|
|                     | (n=238)                     | (n=115)                       | (n=119)                        |                |
| Patient delay       | 41 (15-85)                  | 75 (29-170)                   | 52 (26-99)                     | 0.009          |
| Call to scene       | 6 (4-7)                     | 17 (10-22)                    | 14 (10-19)                     | <0.001         |
| Time at scene       | 20 (15-25)                  | 16 (8-22)                     | 18 (12-23)                     | 0.002          |
| Scene to PCI center | 9 (7-12)                    | 60 (50-70)                    | 91 (75-125)                    | <0.001         |
| Door to balloon     | 45 (33-70)                  | 30 (20-39)                    | 30 (23-45)                     | <0.001         |
| Pre-hospital delay  | 35 (29-43)                  | 98 (82-129)                   | 135 (110-173)                  | <0.001         |
| FMC to balloon      | 79 (65-100)                 | 119 (102-168)                 | 160 (128-210)                  | <0.001         |
| System delay        | 86 (72-113)                 | 133 (116-178)                 | 173 (145-215)                  | <0.001         |
| Treatment delay     | 135 (100-200)               | 235 (158-350)                 | 235 (187-330)                  | <0.001         |

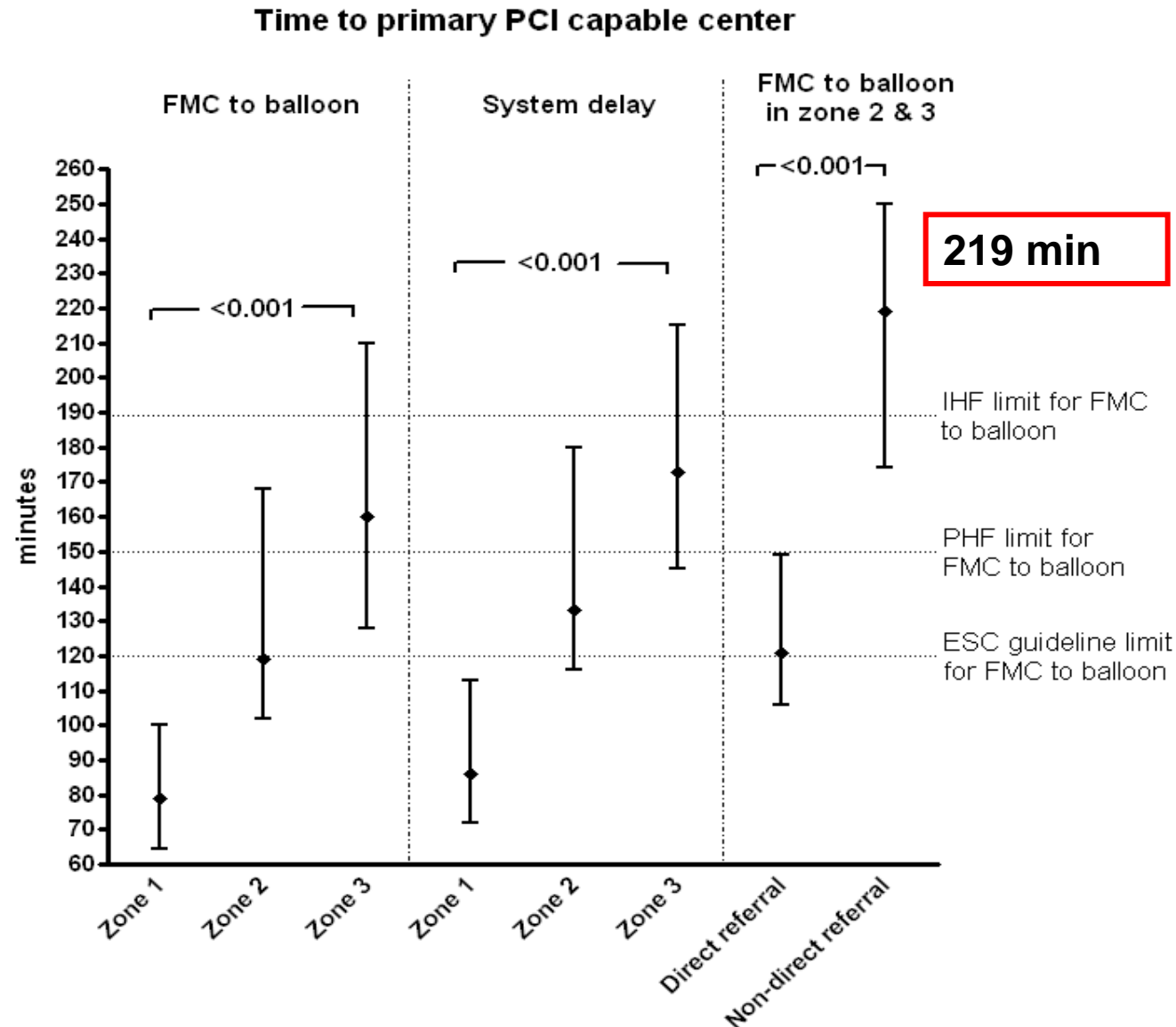
# Results: Complications during transfer and mortality

|                                  | Zone 1<br>(0-25 km) | Zone 2<br>(65-100 km) | Zone 3<br>(100-185 km) | P value |
|----------------------------------|---------------------|-----------------------|------------------------|---------|
| VF/VT/asystoly                   | 18 (7.6)            | 12 (10.4)             | 14 (11.8)              | 0.178   |
| SBT <100                         | 49 (20.6)           | 11 (9.6)              | 18 (15.1)              | 0.092   |
| HR >100                          | 33 (13.9)           | 21 (18.9)             | 14 (11.4)              | 0.736   |
| AV block >2 <sup>nd</sup> degree | 4 (1.7)             | 4 (3.5)               | 2 (1.7)                | 0.842   |
| Killip class 2-4                 | 26 (11.8)           | 13 (12.5)             | 8 (7.8)                | 0.731   |
| Mortality 24 hours               | 10 (4.2)            | 1 (0.9)               | 1 (0.8)                | 0.036   |
| Mortality 7 days                 | 16 (6.8)            | 4 (3.5)               | 5 (4.2)                | 0.239   |
| Mortality 30 days                | 19 (8.1)            | 7 (6.1)               | 8 (6.8)                | 0.501   |
| Mortality Final follow-up        | 56 (23.8)           | 23 (20)               | 20 (16.9)              | 0.126   |

# Results: Reperfusion delays



| Direct referral<br>FMC to balloon |                             |
|-----------------------------------|-----------------------------|
| Zone 2                            | Zone 3                      |
| <b>109 min</b><br>(92-121)        | <b>139 min</b><br>(121-160) |





ST-segment elevation

# Pre-hospital triage feasible in 73% of STEMI patients (self-presenters excluded)

Self presentation

7%

Zone 2 & 3 (n=234)

# 2011 Single Center Experience

RF

1282 Consecutive acute CAG  
(IHD, Chest pain, Cardiogenic shock, OHCA)

702 Tele-ECG Triage

580 Transferred from spo

P PCI 81%



P PCI 41%

# **STEMI time delays when using Ambulances or Helicopters**



# STEMI - Methods

- Prospective, controlled, observational
- Ambulance 16 months vs Helicopter 12 months
- STEMI transferred for pPCI
- >30 min. Transport by Ambulance
- Both prehospital and interhospital



# Time analysis - STEMI



Symptoms  
112

Arrival  
EKG





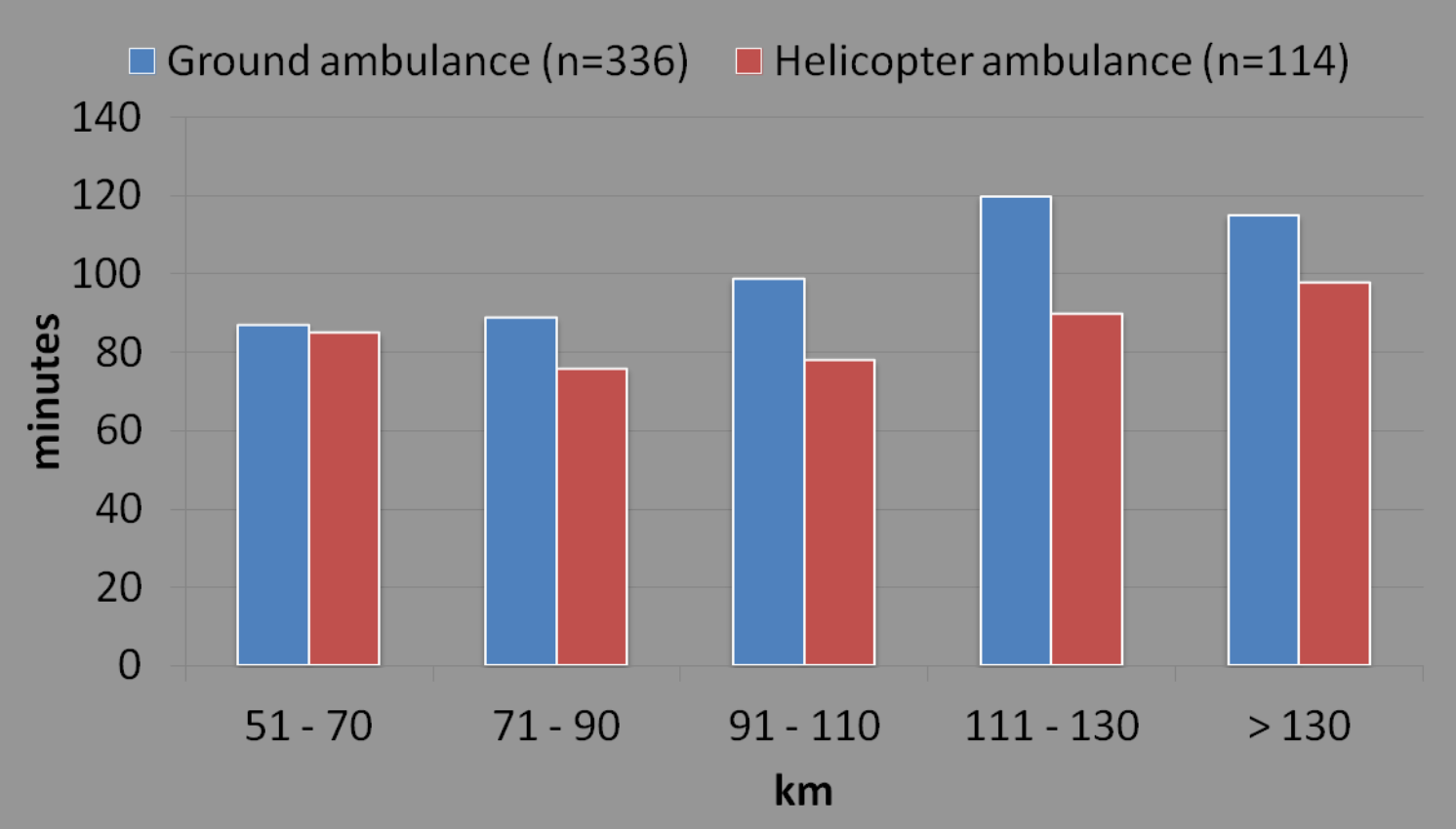
# STEMI Time delays

| All transferred pts | Ambulance<br>n=336 | Helicopter<br>n=114 | P value |
|---------------------|--------------------|---------------------|---------|
| ECG – Cath Lab      | 104 (63-225)       | 84 (60-160)         | <0.01   |
| Distance in km      | 94 (64-162)        | 97 (65-172)         | 0.01    |
|                     | n=262              | n=91                |         |
| Symptoms - ECG      | 90 (21-497)        | 90 (16-405)         | 0.80    |
| ECG / FMC - Balloon | 132 (84-262)       | 114 (78-221)        | <0.01   |
| <120 min            | 48%                | 65 %                | <0.01   |
| Door-2-Balloon      | 32 (18-70)         | 32 (20-82)          | 0.66    |

# STEMI - Mortality

- 30 - day mortality
  - Ambulance (n=262) vs. Helicopter (n=91)  
(6.9 % vs. 2.2%, p=0.10)
- 1 – yr mortality
  - Ambulance (n=262) vs. Helicopter (n=90)  
(9.9 % vs. 6.7%, p=0.35)

# Time from ECG to PCI center



+ 30 minutes door-to-ballon

Hesselfeldt et al. Submitted

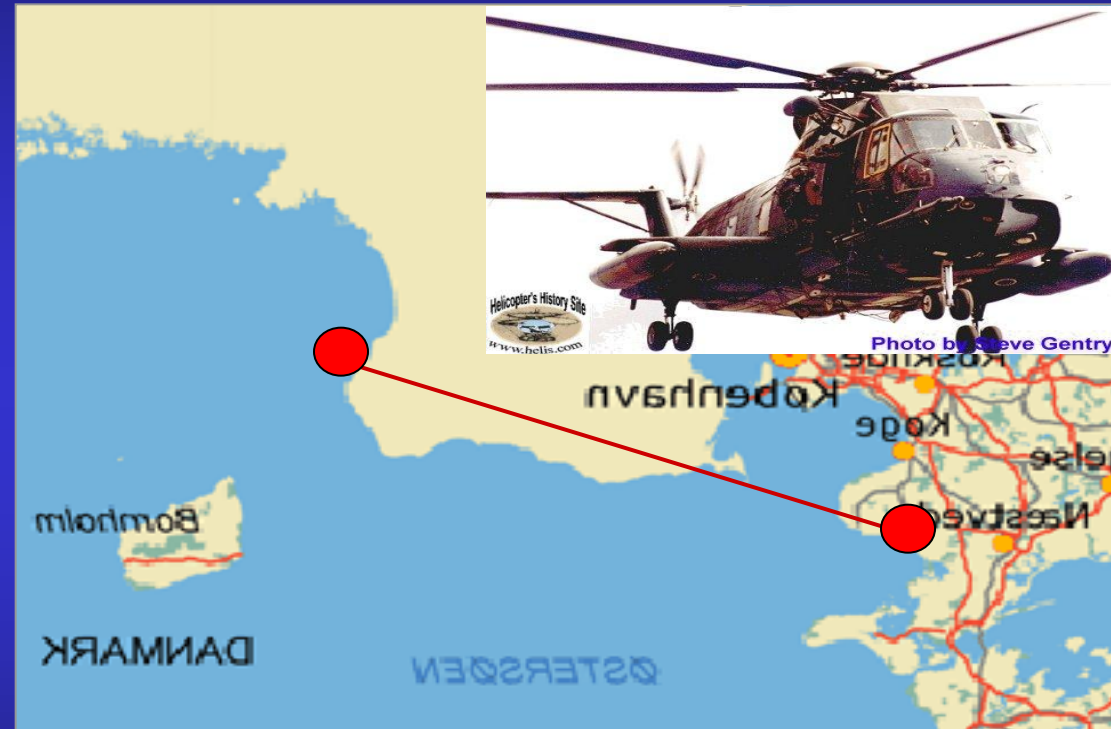


Webcam from helipad to cath lab

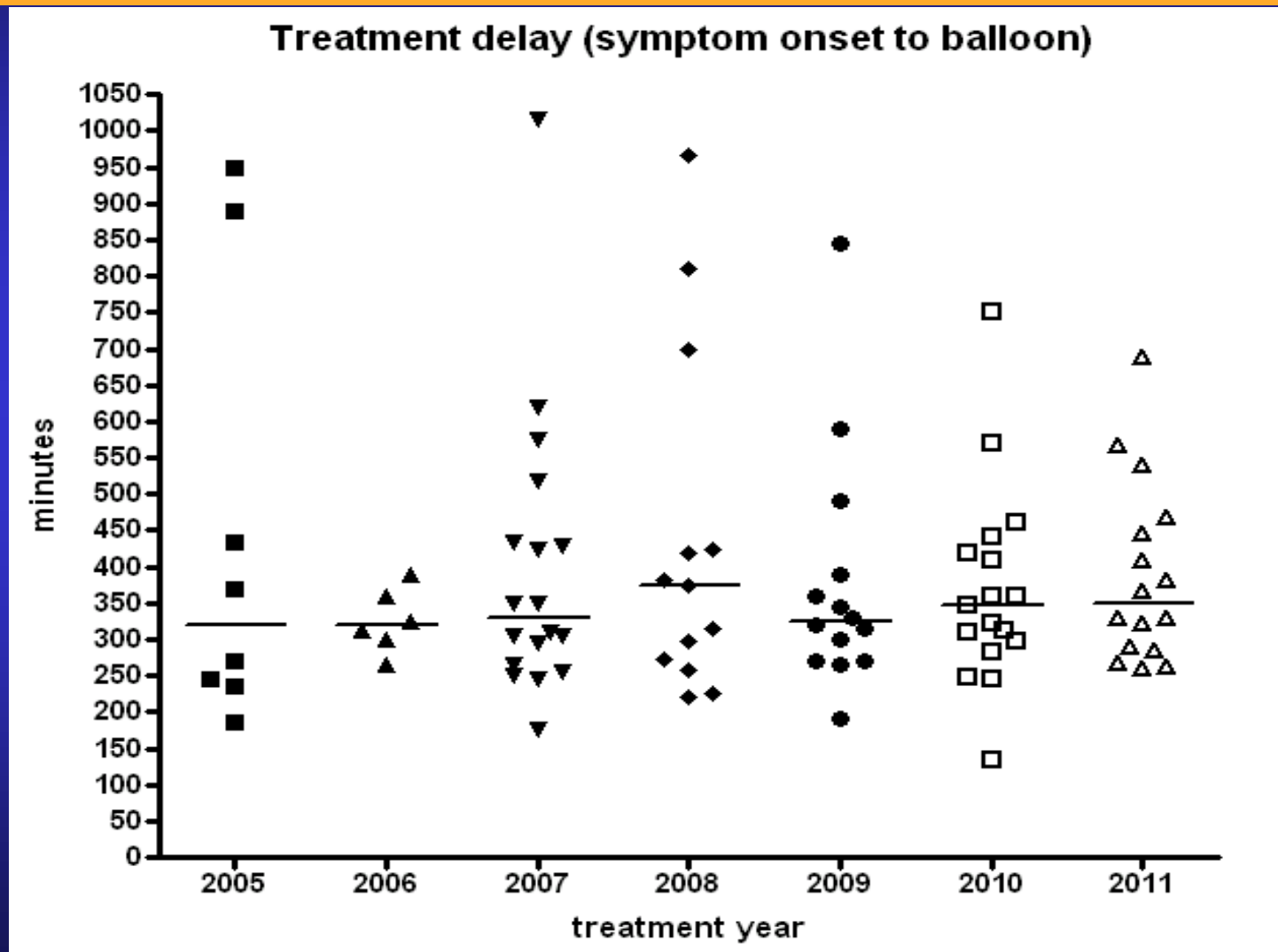


# Telemedicine based STEMI-Transfer Baltic Sea Island

|                                |               |
|--------------------------------|---------------|
| 112 - Ambulance Arrival:       | 15 min        |
| ECG                            | 7 min         |
| Phone-Calls:                   | 5 min         |
| Helicopter-Flying Time:        | 42 min        |
| Medication and Out:            | 10 min        |
| Ambulance to Rønne: 12 min     |               |
| Waiting for Helicopter: 20 min |               |
| Helicopter Transfer:           | 40 min        |
| <b>ECG to Rigshospitalet:</b>  | <b>94 min</b> |







Overall median = 331 minutes (n = 94)

# Mortality

|                         | Bornholm<br>2005-2011<br>(n=101) | Capitol region<br>1998-2008<br>(n=2774) |
|-------------------------|----------------------------------|---|
| 30 d cardiac mortality  | 6 (5.9 %)                        | 205 (7.4 %)                             |
| 1. Yr cardiac mortality | 7 (7.7 %)                        | 233 (8.4%)                              |
| 30 d total mortality    | 6 (5.9 %)                        | 222 (8 %)                               |
| 1. års total mortality  | 9 (9.9%)                         | 283 (10.2 %)                            |

# Conclusions

**Telemedicine is pivotal in reducing treatment delays in STEMI networks**

**Primary PCI can be centralized in well organized "Mega-centers" without negative effects of treatment delays**

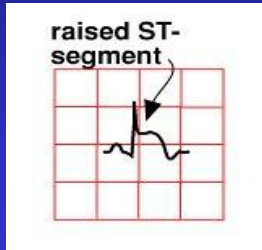
**Helicopter transfer of STEMI patients significantly reduces treatment delays, effective from a radius of only 80 km (50 miles) from the pPCI hub**

Thank you for your attention



# Prehospital ACS Triage

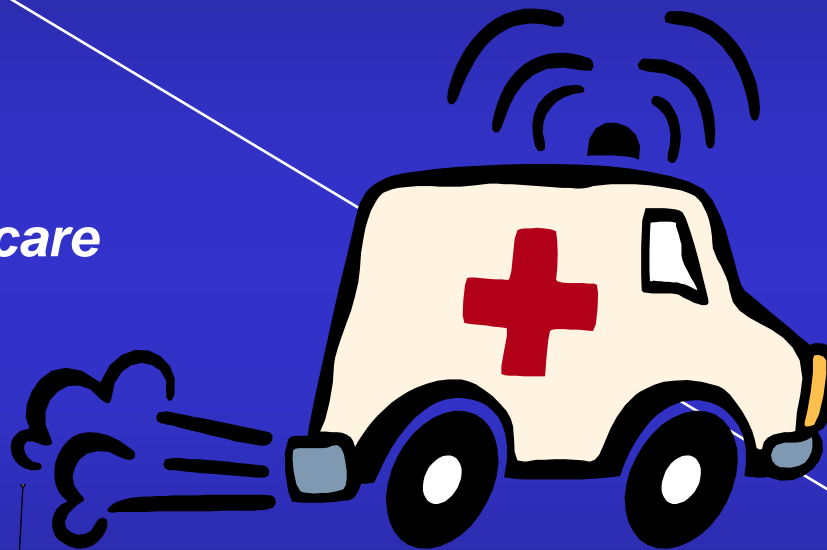
## STEMI Patients



*Pre-hospital point-of-care*

Troponins / FABP / xx

ECHO?



**In Cath Lab**

# Third Universal Definition of Myocardial Infarction



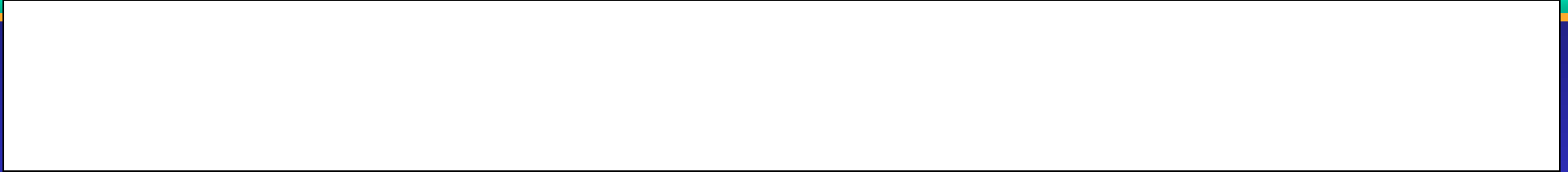
**Peter Clemmensen, MD, DMSc, FESC, FSCAI**  
**Department of Cardiology, Rigshospitalet**  
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**Kristian Thygesen, FESC, FACC, FAHA**  
**Aarhus University Hospital, Aarhus, DK**  
**Co-Chairman of The Global MI Task Force**

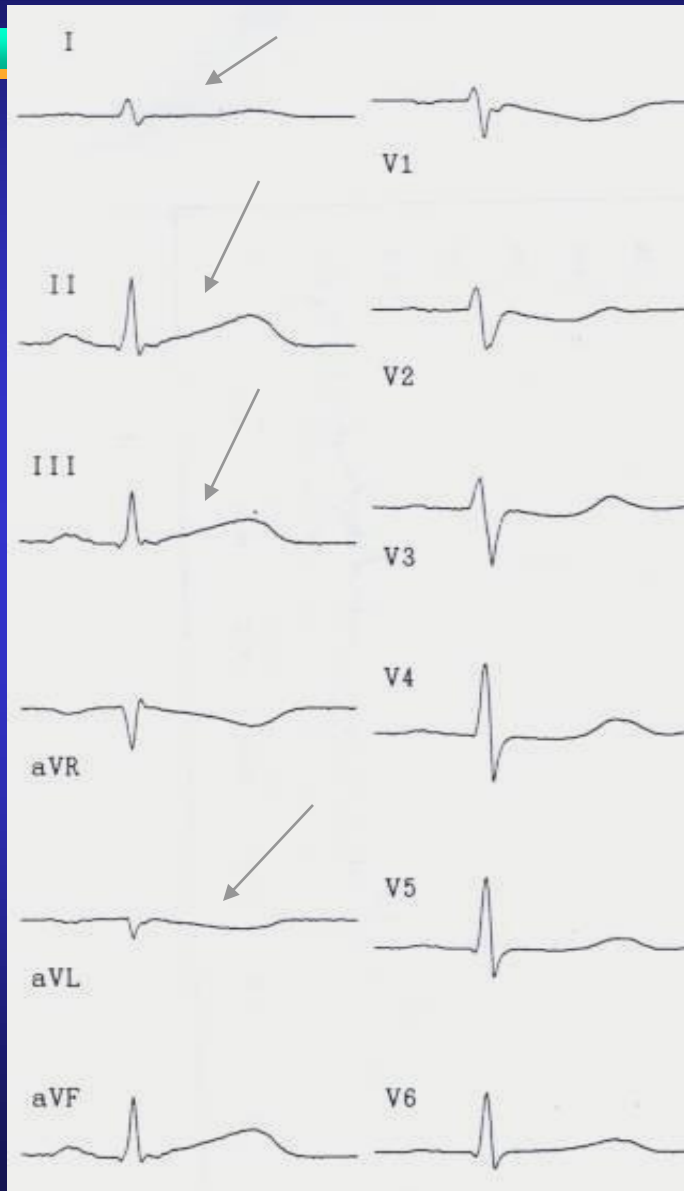




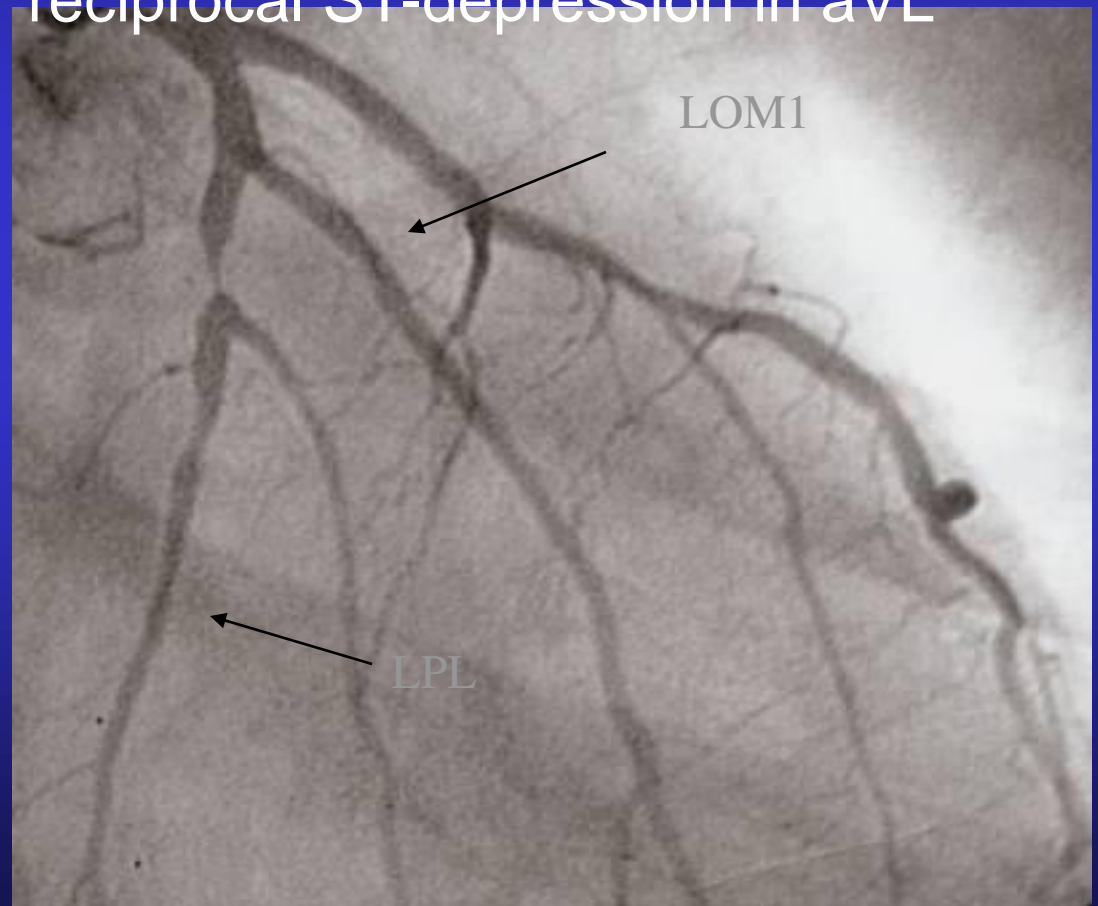
# Patient with chest pain



# Proximal or distal occlusion ?



**DISTAL LCX OCCLUSION**  
post-OM1  
reciprocal ST-depression in aVL



Courtesy of Dr. Kiell Nikus, Tampere

**The best way to predict the future is to create it**

**Peter F. Drucker**



# Single phone call – Team effort



?





# Conclusions

- *Helicopter transfer for STEMI pts with an estimated ground transport > 30 min. to the pPCI center decreases FMC to Balloon times*
- *Using helicopter transfer for STEMI patients results in more pts being treated within the ESC guideline limits*
- *Our initial experience suggest that Helicopter transfer for STEMI patients is faster than ground transport even at distances down to 80 km  
(50 miles)*

|                           | Bornholm<br>2005-2011<br>(n=101) | Alle STEMI patienter<br>behandlet på RH med pPCI<br>fra 1998-2008<br>(n=2774) |
|---------------------------|----------------------------------|---|
| Age                       | 62.2 ± 12.6                      | 62.7 ± 13.1   |
| Gender (female)           | 18 (17.8)                        | 788 (28)  |
| Hypertension              | 32 (31.7)                        | 788 (33)  |
| Dyslipidemia              | 24 (23.8)                        | 468 (32)  |
| Active or previous smoker | 68 (67.3)                        | 1752 (79)   |
| Diabetes                  | 9 (8.9)                          | 415 (15)  |
| BMI                       | 27.4 ± 5.3                       | 26.5 ± 4.4  |
| Culprit artery            |                                  |   |
| LAD                       | 44 (43.6)                        | 1286 (45)   |
| RCA                       | 42 (41.6)                        | 1117 (41)   |
| LCX                       | 12 (11.9)                        | 337 (13)  |
| LM                        | 2 (2)                            | 23 (0.8)  |
| TIMI 0/I/II/III (%)       | 55/12/14/19                      | 65/8/14/13  |
| 1/2/3/>3 lesions (%)      | 77/16/5/2                        | 79/17/3/1   |

# Denmark 5.5 M Inhabitants

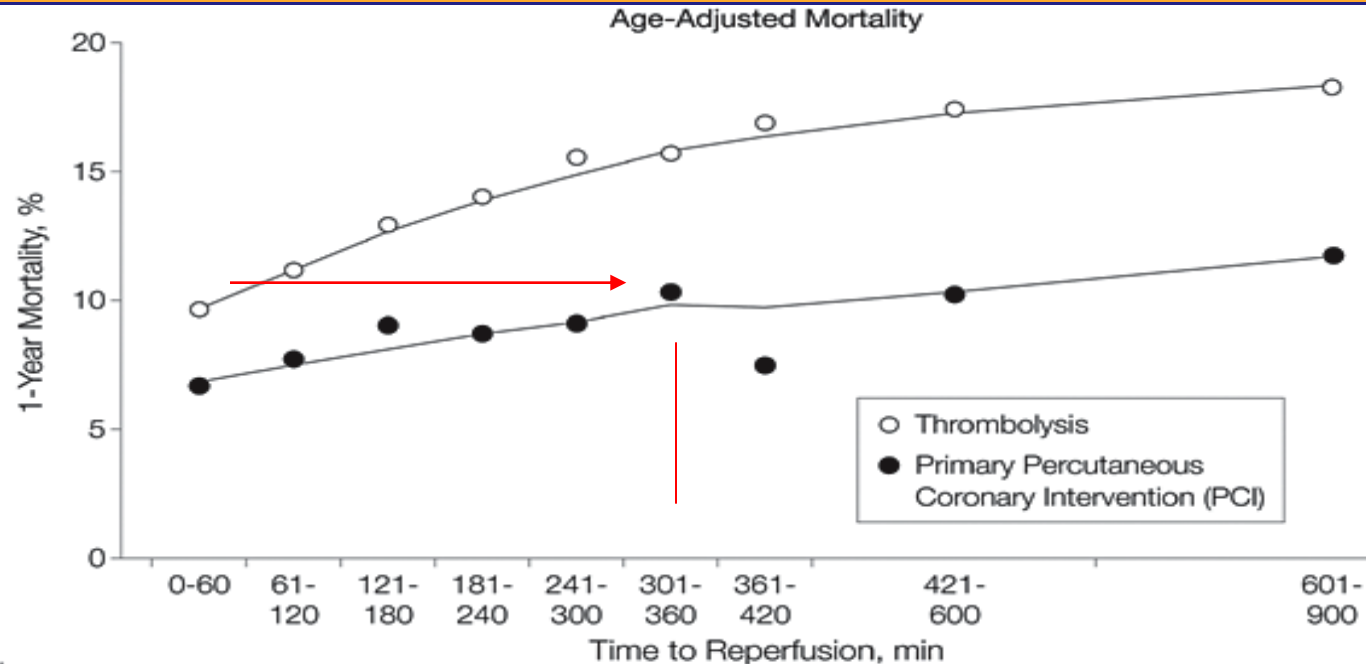
Tele  
Transmission  
between  
6 Elective PCI  
or CAG Centers

and

4 pPCI  
University Centers



# Age-Adjusted Mortality According to Time to Reperfusion and Type of Therapy

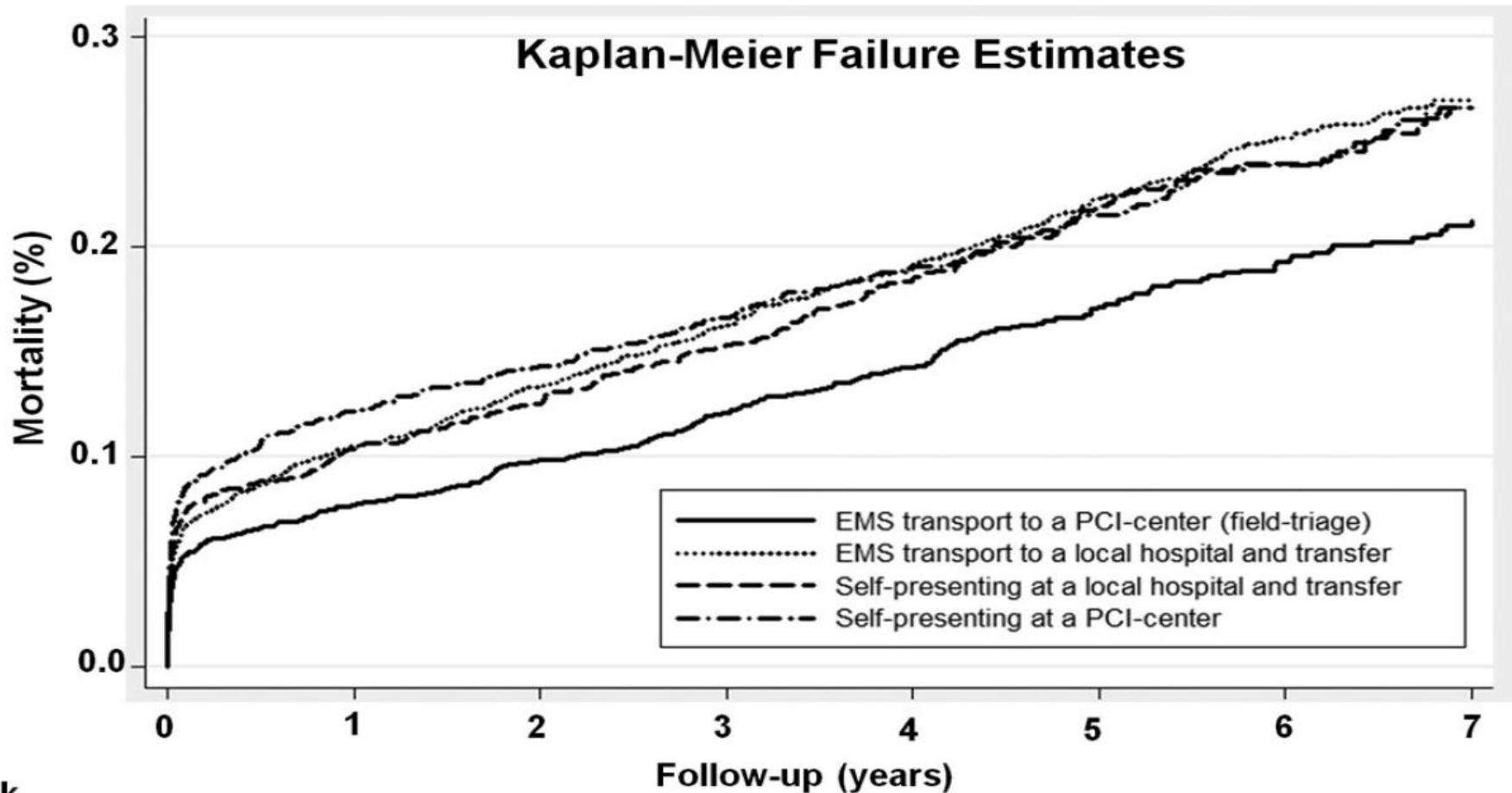


|                       | 0-60 | 61-120 | 121-180 | 181-240 | 241-300 | 301-360 | 361-420 | 421-600 | 601-900 |
|-----------------------|------|--------|---------|---------|---------|---------|---------|---------|---------|
| <b>Thrombolysis</b>   |      |        |         |         |         |         |         |         |         |
| No. of Deaths         | 122  | 503    | 503     | 332     | 239     | 159     | 121     | 196     | 139     |
| Total No. of Patients | 1248 | 4375   | 3659    | 2199    | 1438    | 946     | 658     | 1061    | 703     |
| <b>Primary PCI</b>    |      |        |         |         |         |         |         |         |         |
| No. of Deaths         | 7    | 61     | 81      | 50      | 43      | 37      | 17      | 41      | 31      |
| Total No. of Patients | 125  | 895    | 1126    | 776     | 567     | 453     | 282     | 458     | 332     |

Stenestrand, U. et al.

JAMA 2006;296:1749-1756.

# Outcome according to triage of patients



No. at risk

|         | 0    | 1    | 2    | 3    | 4    | 5    | 6   | 7   |
|---------|------|------|------|------|------|------|-----|-----|
| —       | 3053 | 2503 | 1978 | 1533 | 1154 | 808  | 572 | 358 |
| .....   | 3291 | 2850 | 2535 | 2143 | 1758 | 1344 | 919 | 543 |
| - - -   | 1514 | 1280 | 1126 | 965  | 785  | 603  | 432 | 286 |
| - . - . | 1656 | 1348 | 1142 | 911  | 713  | 527  | 371 | 244 |



# PCI Mega center

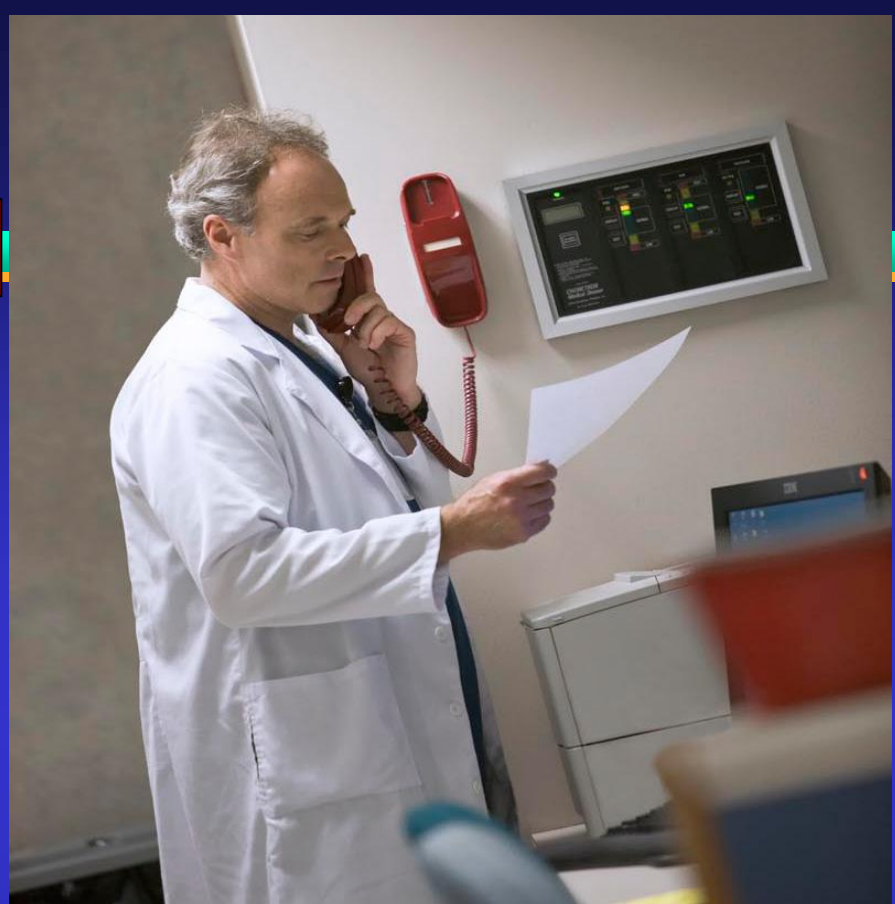
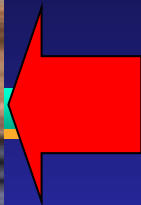


Optimal catchment area for pPCI: 250-500.000  
Should rarely exceed 1.000.000

# Level 1 MI Emergency Department Kit Going prehospital !

- ASA tablets in package and i.v.
- Prasugrel, Ticagrelor, Clopidogrel tables in package
- Metoprolol bolus x3
- Heparin bolus
- Bivalirudin drip and tubing
- Alcohol swabs
- Calculator
- Standing orders with fibrinolytic calculations
- Blood vials
- PCS forms (Physician Certification Statement for Transfer)
- Transfer datasheet
- Standing orders





KPI

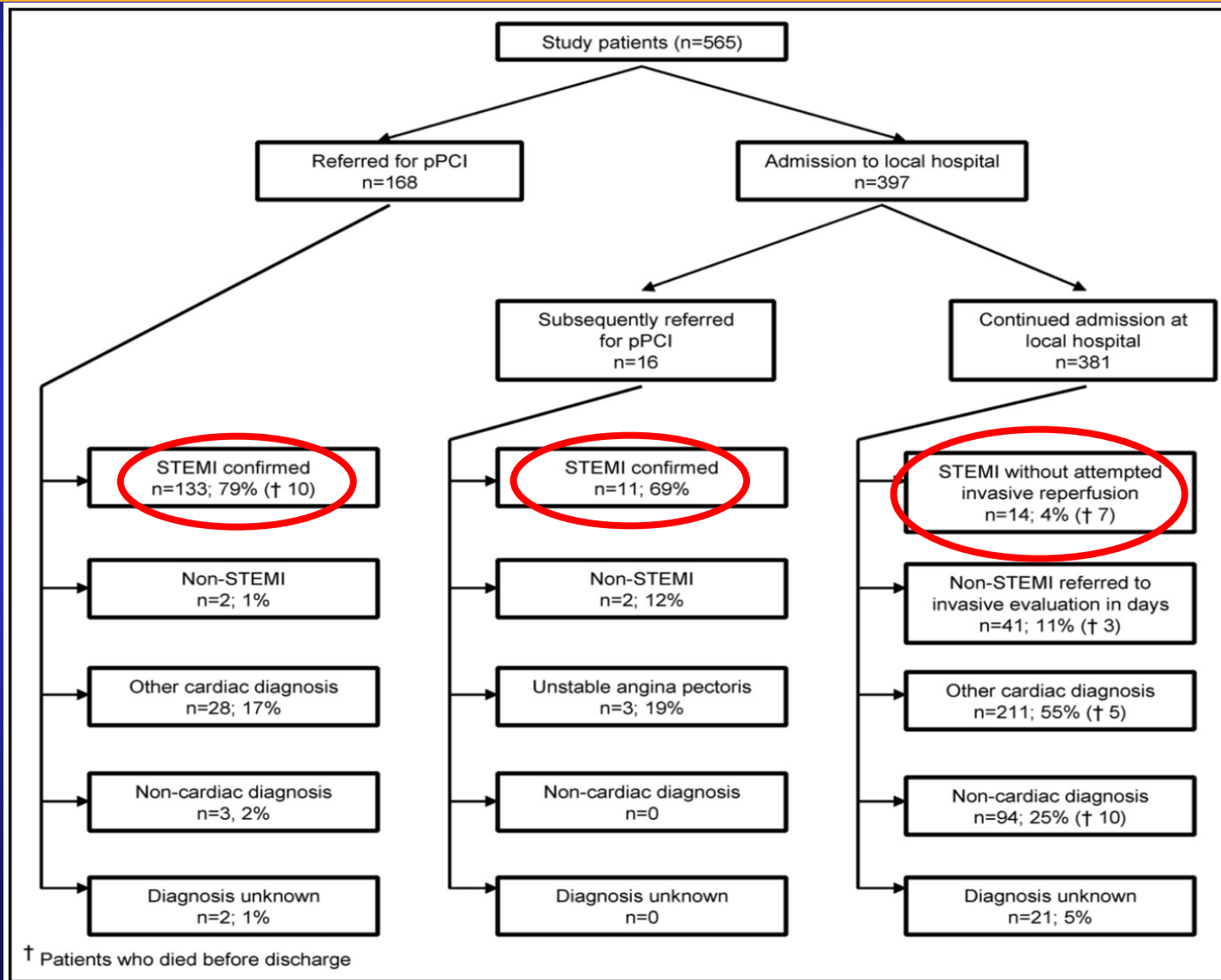
Call back 90 sec. after incoming ECG



# From High Volume to Mega-Center pPCI Center



# Real World Tele-ECG Triage



## *STEMI diagnosis*

- PPV 79%
- NPV 94%
- Sensitivity 84%
- Specificity 91%