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TORINESI**

**TURIN,  
October  
25<sup>th</sup>-27<sup>th</sup>  
2018**  
Starhotels Majestic

UNIVERSITÀ DEGLI STUDI DI TORINO

AZIENDA OSPEDALIERO-UNIVERSITARIA  
Città della Salute e della Scienza di Torino

## Remote PCI

Amir Lerman, MD

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Director Cardiovascular Research Center  
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Mayo Clinic, Rochester, MN

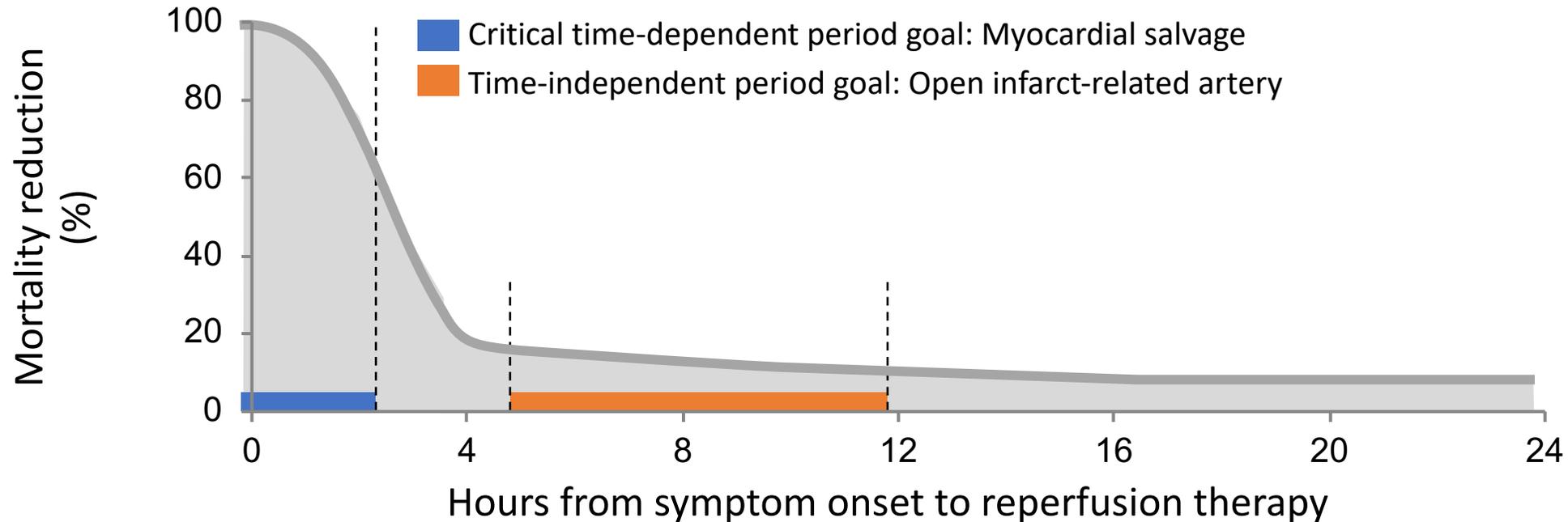
# Disclosures

Consultant: Corindus

# Background

- Estimates on annual incidence of AMI
  - ~ 595,000
- Longer ischemic time is associated with increased cell death and adverse outcomes
- Accelerating the process of restoring flow
  - Key goal of ACC and other professional societies
  - D2B now a metric of success and quality of care

# Why is It Important to Address this Problem?



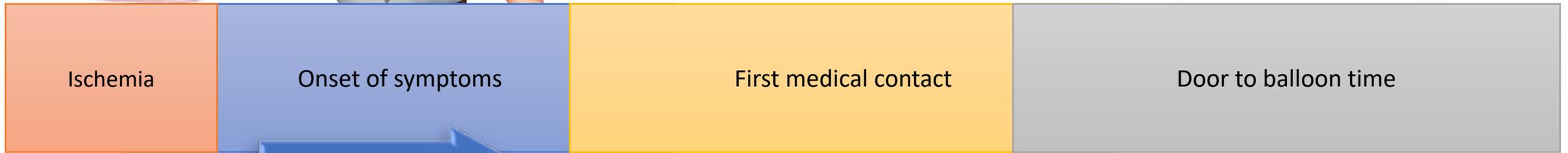
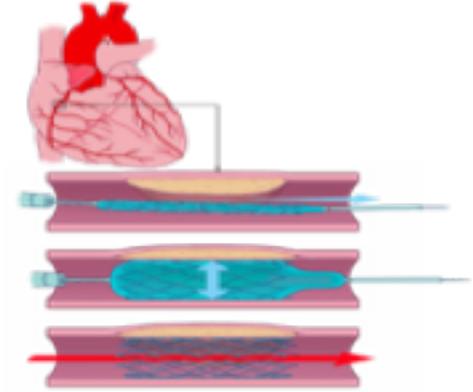
## For every 30-minute delay in time to treatment

- 7.5% increase in mortality
- 8.7% increase in low EF leading to CHF (rate almost doubles post recurrent MI)

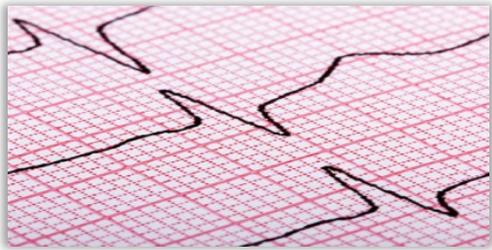
## HF is the most costly DRG in the USA

- Late arrival is costly not only to patient's life and heart but to our country's health care system

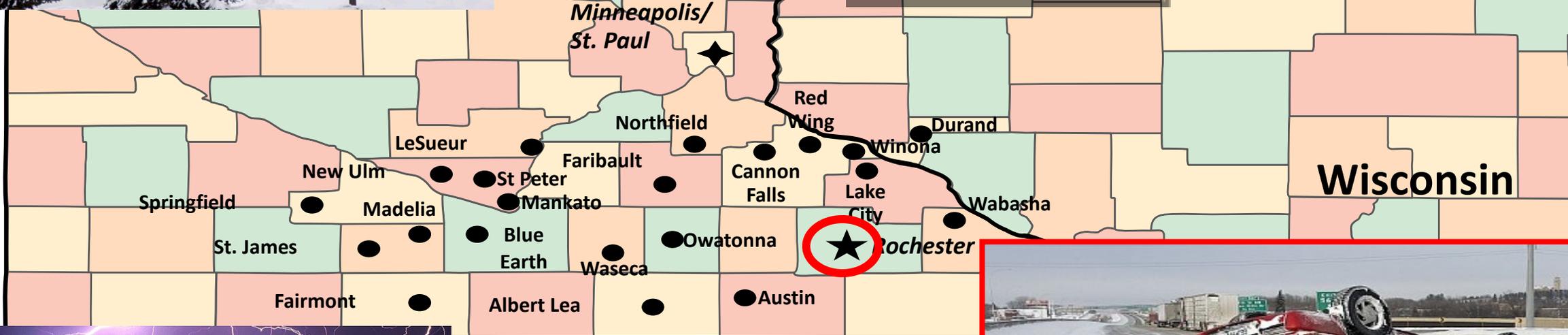
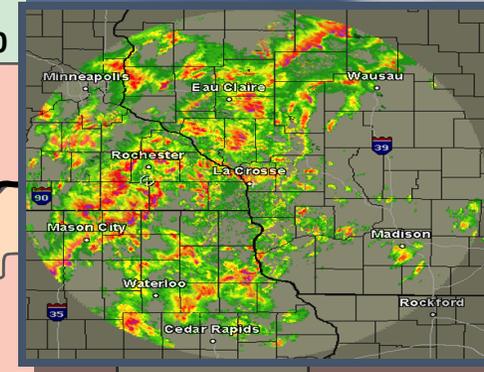
# Ischemia to Balloon Time



ECG changes

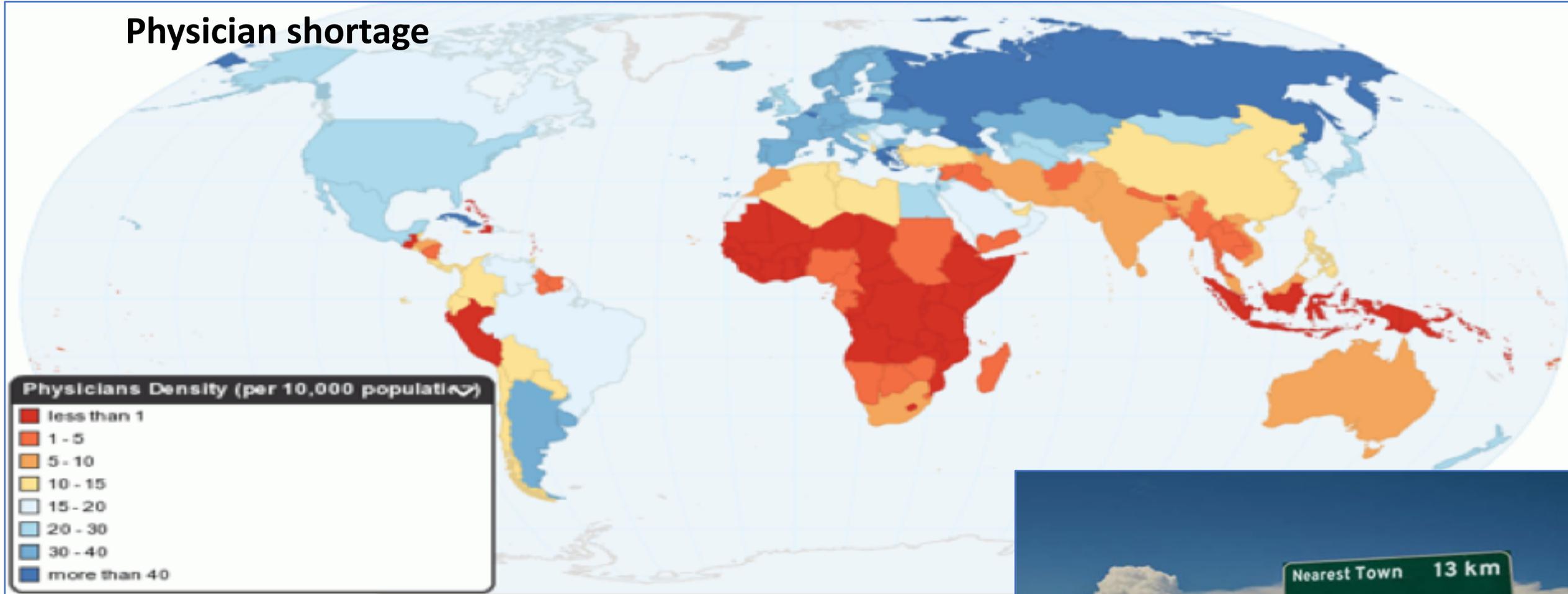


Rochester, Minnesota – December and January and February and March and April



# Standardization and equalizing Access to care

## Physician shortage



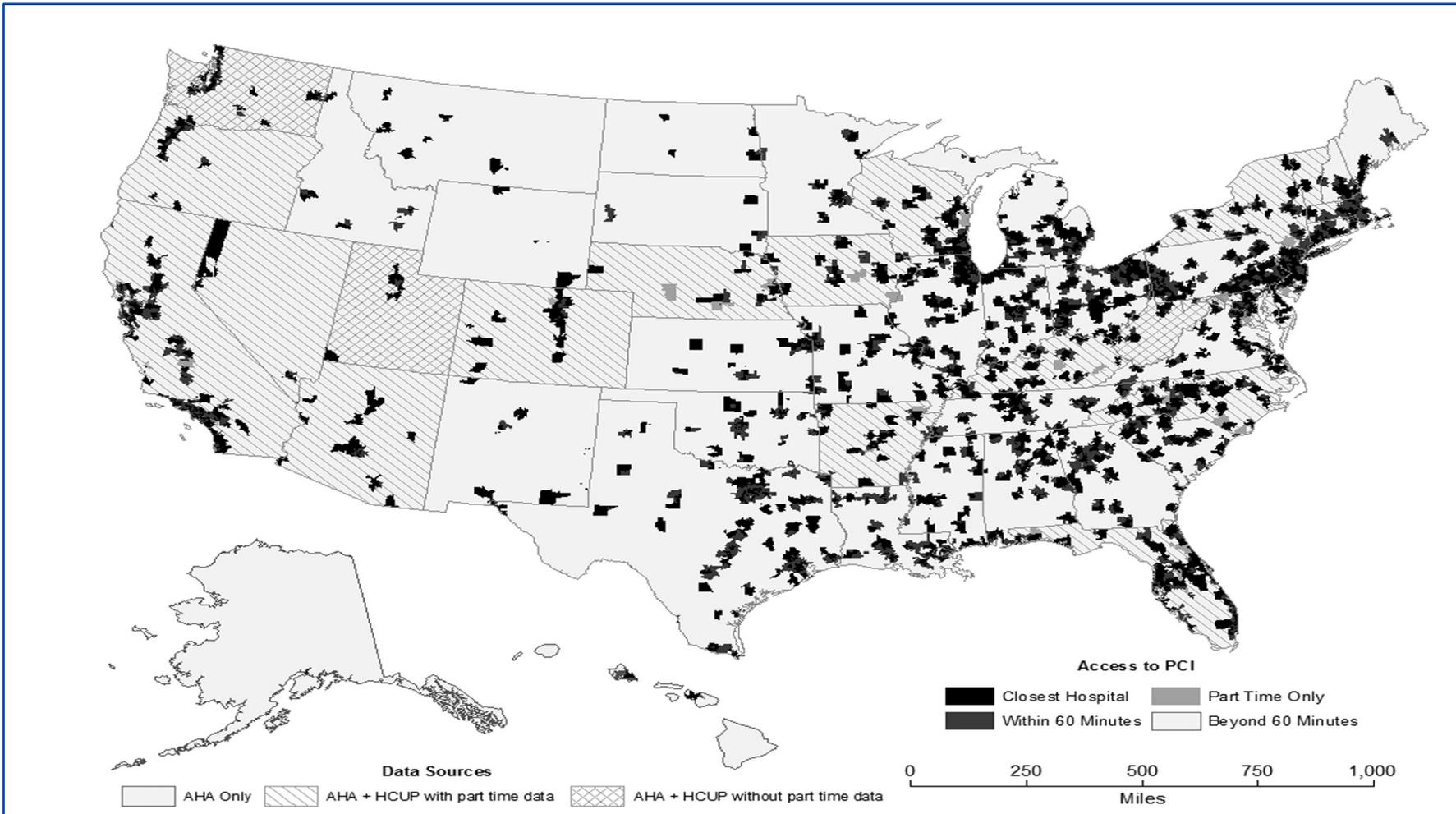
Anticipated 90,000 physicians shortage in the US until 2025



## A Percutaneous Coronary Intervention Lab in Every Hospital?

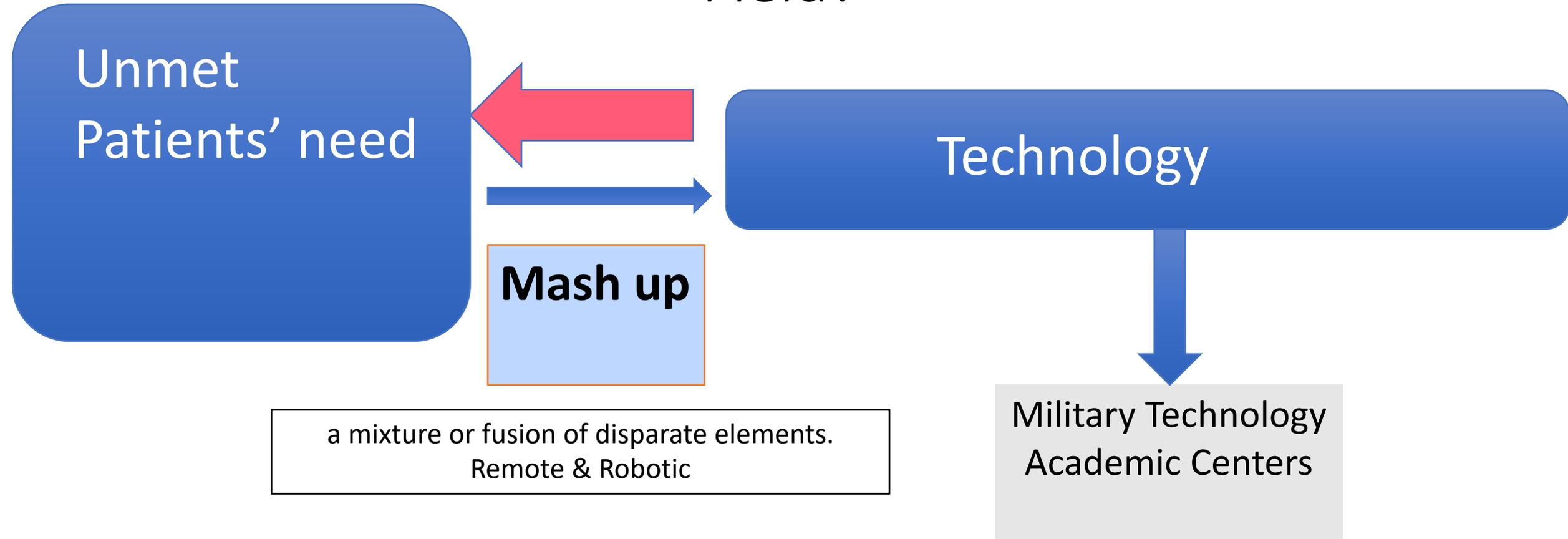
Thomas W. Concannon, PhD; Jason Nelson, MPH; Jessica Goetz, MPH; John L. Griffith, PhD

### Dark Areas: <60-min Drive to PCI Hospital



From 2001 to 2006, hospital capability to perform PCI grew by 44%, whereas timely access to the procedure grew by only 1%.

# Where are the Future Opportunities in the Cardiovascular Field?

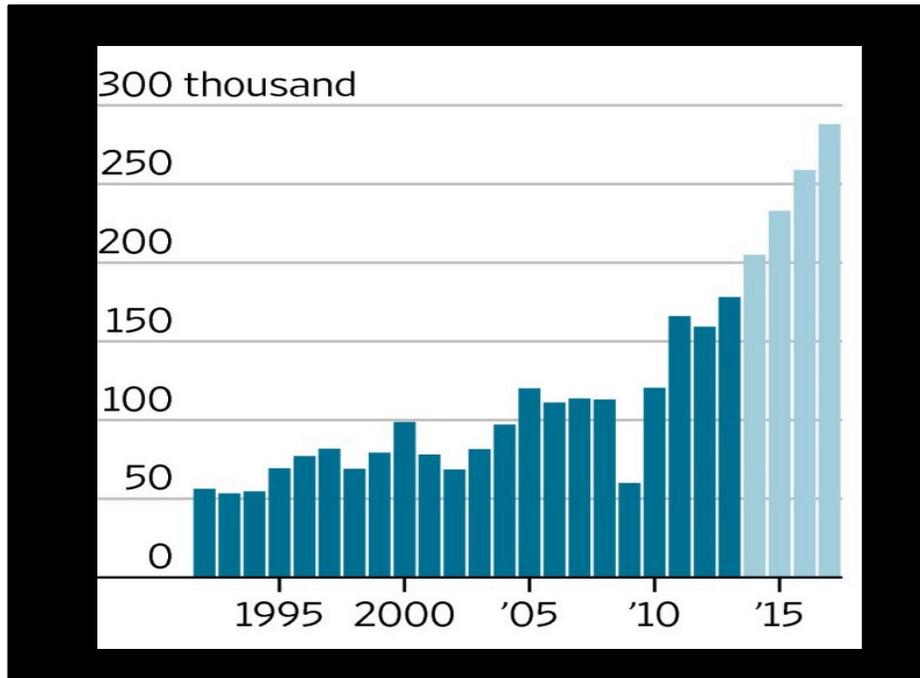


# If you can not bring the patients to the cath lab: bring the cath lab to the patients

- Challenges
- Mash up: Remote Robotic
- Robotic
  - Safety and Feasibility
  - Reaction time
- Remote
  - Face to face interaction

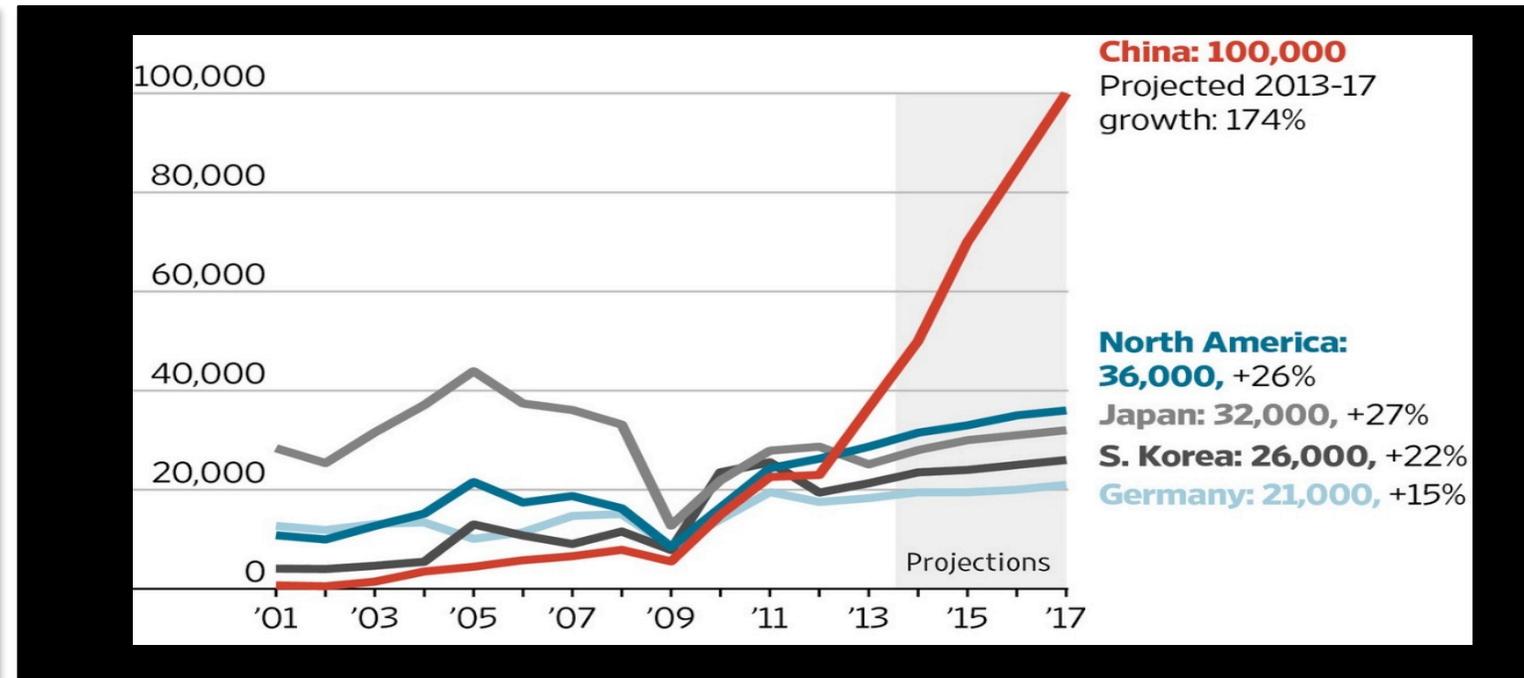
# Robotic Revolution; across all industries

World-wide industrial robot installations



Automatic Nations

Top 5 markets for industrial robot sales



We now drive cars, have vision & vacuum robotically...we will not be manually controlling catheters in the future...



**Robots can now assemble an IKEA chair in 20 minutes—without fighting**  
Caroline Purtil | April 15, 2018



# Robotics in the Cath Lab

## Second Generation Robotic-assisted PCI System

### CorPath® GRX System

#### BEDSIDE UNIT

Optimized bedside unit for radial access

Simple setup & in-procedure workflow

Devices fixed during intervention

Imaging and device agnostic



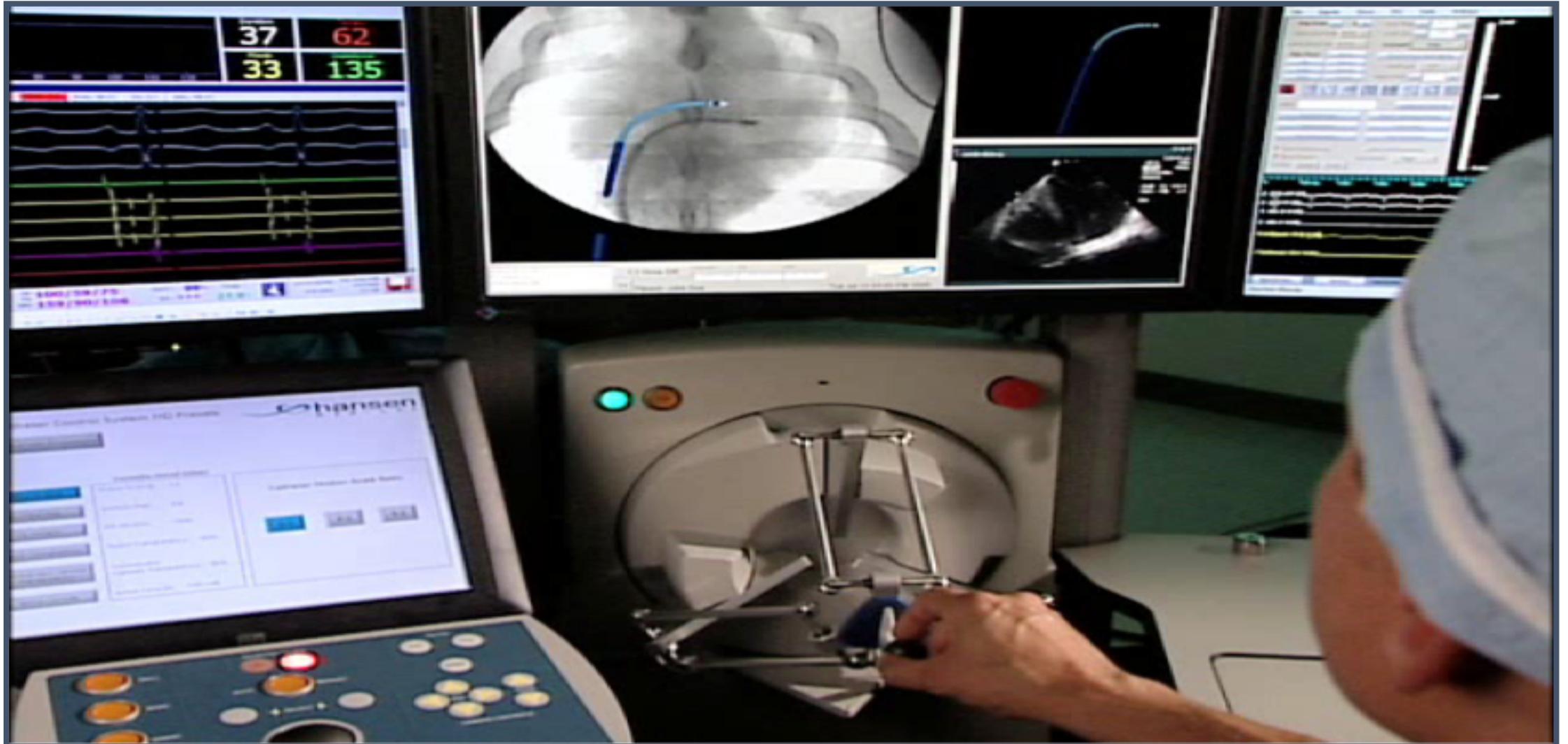
#### INTERVENTIONAL COCKPIT

Precise robotic control of  
Guide catheter  
Guidewire  
Balloon/stent catheter

Radiation-shielded workstation

4K resolution monitor

# The synchrony of imaging and catheter movement ...practice, plan and perfect...

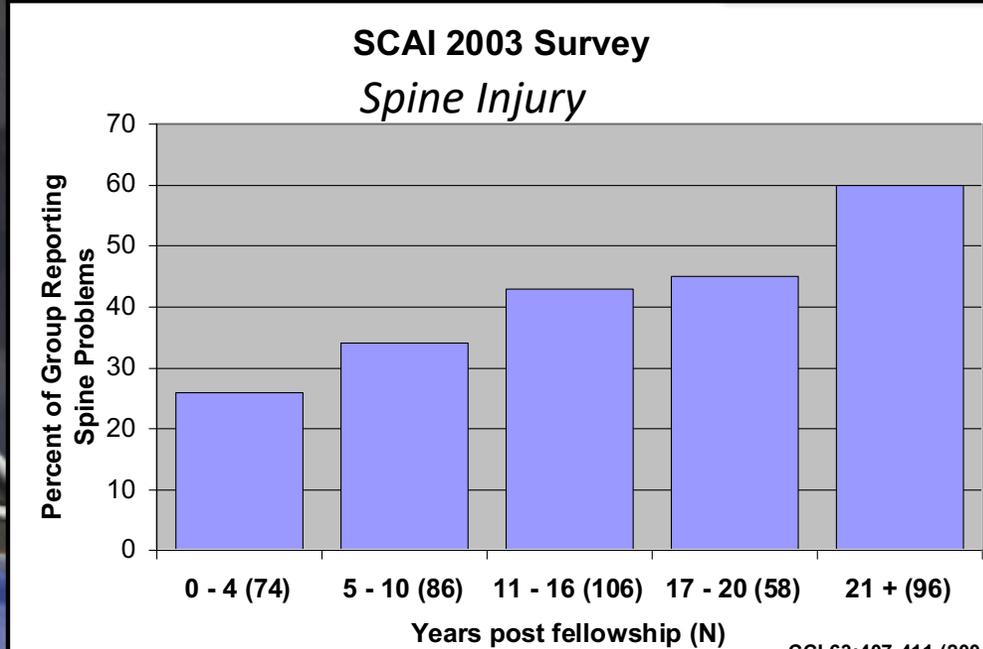
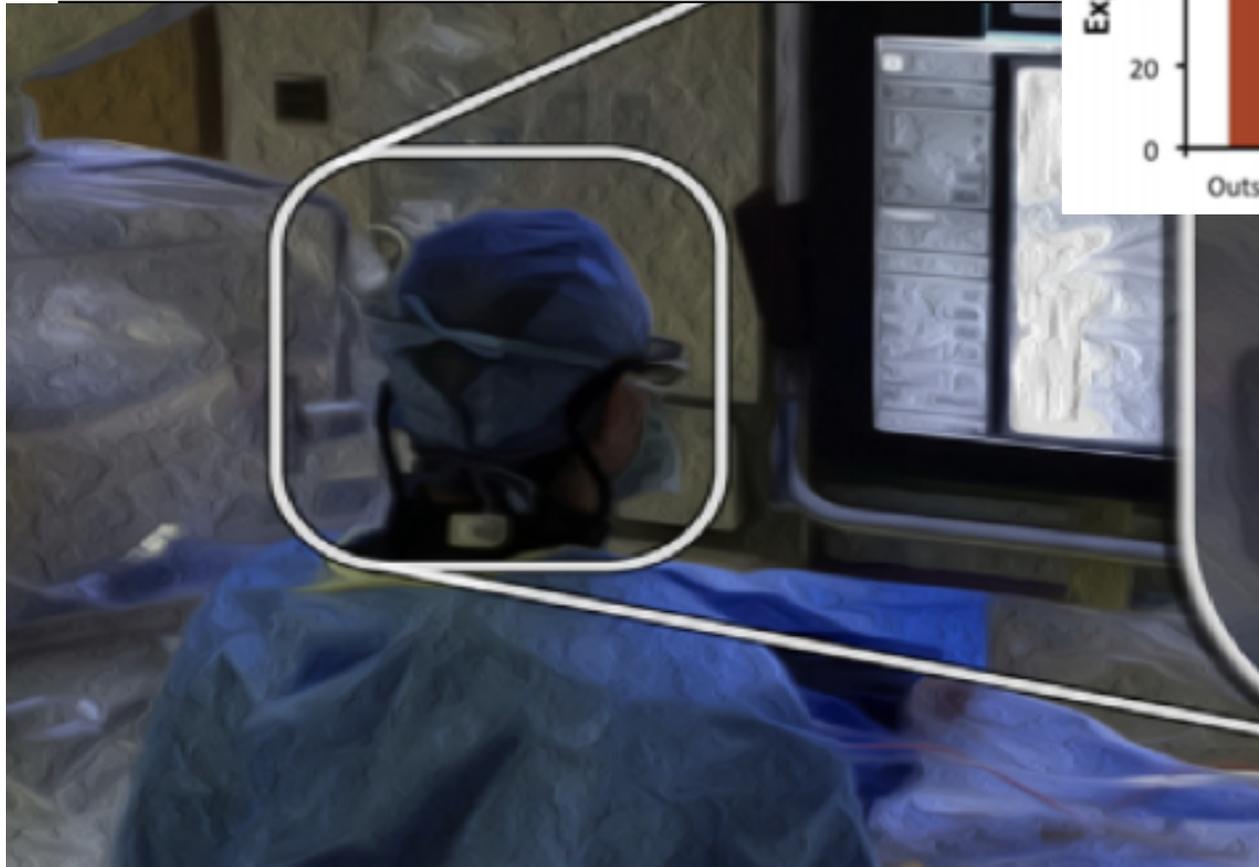
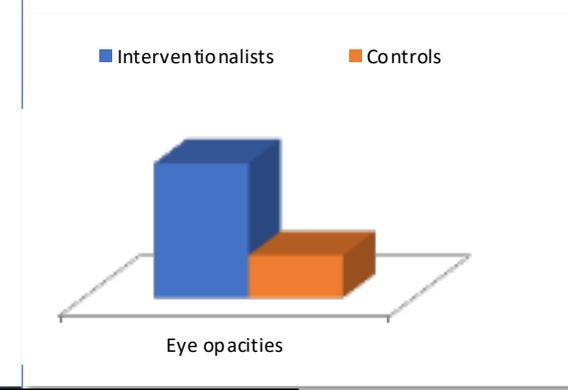
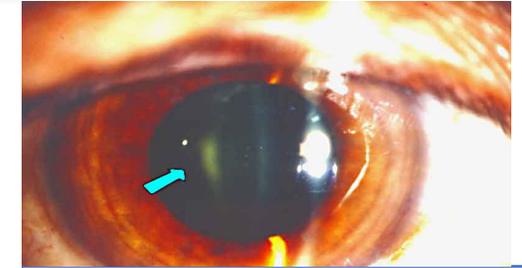
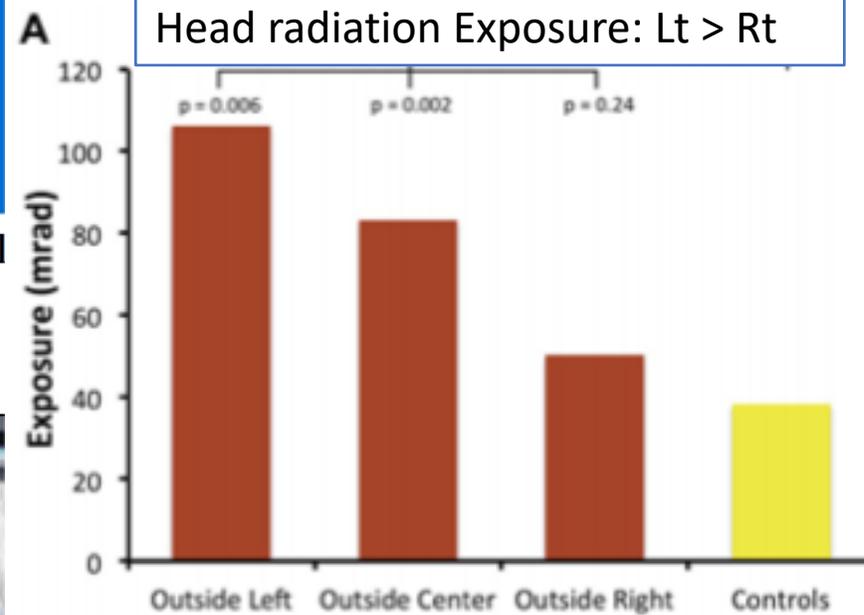


# Operators and patients' safety

*The*  
American Journal  
of  
Cardiology

## Brain and Neck Tumors Among Physicians Performing Interventional Procedures

Ariel Roguin, MD, PhD<sup>a\*</sup>, Jacob Goldstein, MD<sup>b</sup>, Olivier Bar, MD<sup>c</sup>, and James A. Goldstein, MD<sup>d</sup>



# Robotically Assisted PCI: Feasibility and Safety

## Safety and Feasibility of Robotic Percutaneous Coronary Intervention

PRECISE (Percutaneous Robotically-Enhanced Coronary Intervention) Study

Giora Weisz, MD,\* D. Christopher Metzger, MD,† Ronald P. Caputo, MD,‡ Juan A. Delgado, MD,§ J. Jeffrey Marshall, MD,|| George W. Vetrovec, MD,¶ Mark Reisman, MD,# Ron Waksman, MD,\*\* Juan F. Granada, MD,§ Victor Novack, MD, PhD,†† Jeffrey W. Moses, MD,\* Joseph P. Carrozza, MD‡‡  
*New York and Syracuse, New York; Kingston, Tennessee; Medellin, Colombia; Gainesville, Georgia; Richmond, Virginia; Seattle, Washington; Washington, DC; Beersheba, Israel; and Boston, Massachusetts*

Contrast Media Volume, ml



Fluoroscopy Time, min



Radiation Dose, mGy

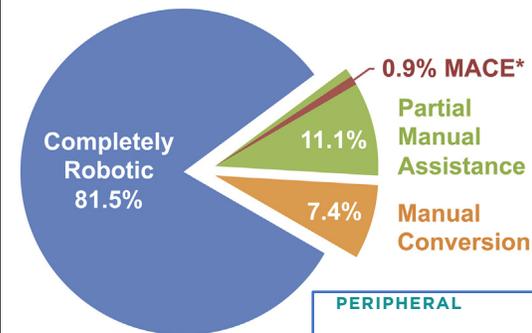


## Demonstration of the Safety and Feasibility of Robotically Assisted Percutaneous Coronary Intervention in Complex Coronary Lesions

Results of the CORA-PCI Study (Complex Robotically Assisted Percutaneous Coronary Intervention)

Ehtisham Mahmud, MD, Jesse Naghi, MD, Lawrence Ang, MD, Jonathan Harrison, MD, Omid Behnamfar, MD, Ali Pourdjabbar, MD, Ryan Reeves, MD, Mitul Patel, MD

FIGURE 3 Technical Success of Robotic Percutaneous Coronary Intervention



## PERIPHERAL

## Feasibility and Safety of Robotic Peripheral Vascular Interventions

Results of the RAPID Trial

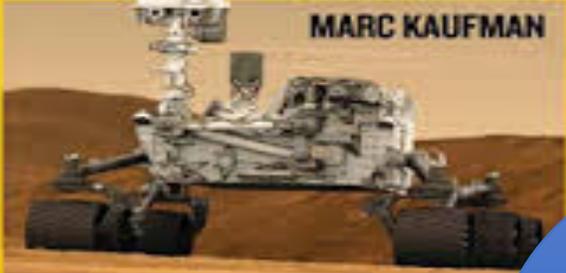
Ehtisham Mahmud, MD,<sup>a</sup> Florian Schmid, MD,<sup>b</sup> Peter Kalmar, MD,<sup>b</sup> Hannes Deutschmann, MD,<sup>b</sup> Franz Hafner, MD,<sup>c</sup> Peter Rief, MD,<sup>c</sup> Marianne Brodmann, MD<sup>c</sup>

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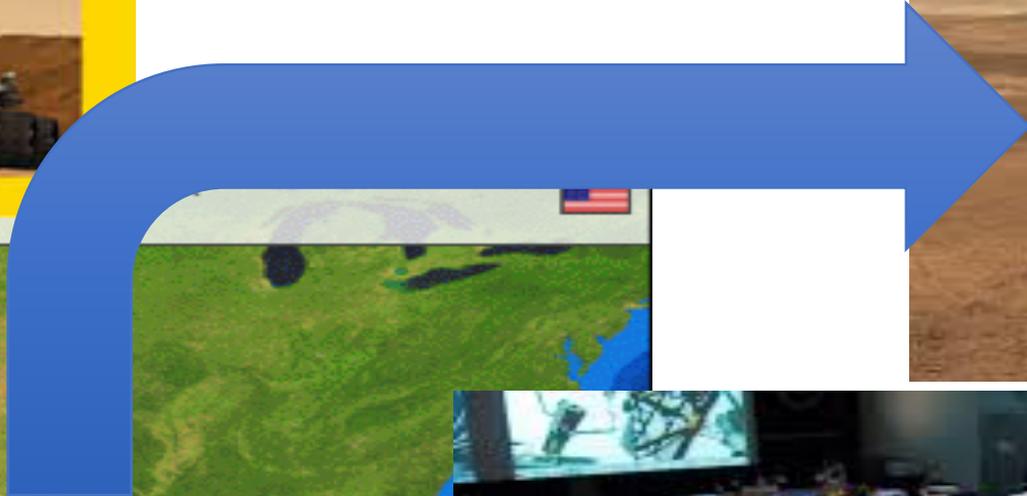
- Challenges
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# MARS LANDING 2012

MARC KAUFMAN



distance from the Earth to Mars is about 54.6 million kilometers  
the communication time delay between Earth and Mars, which is about 20 minutes  
on average.



Houston, United States



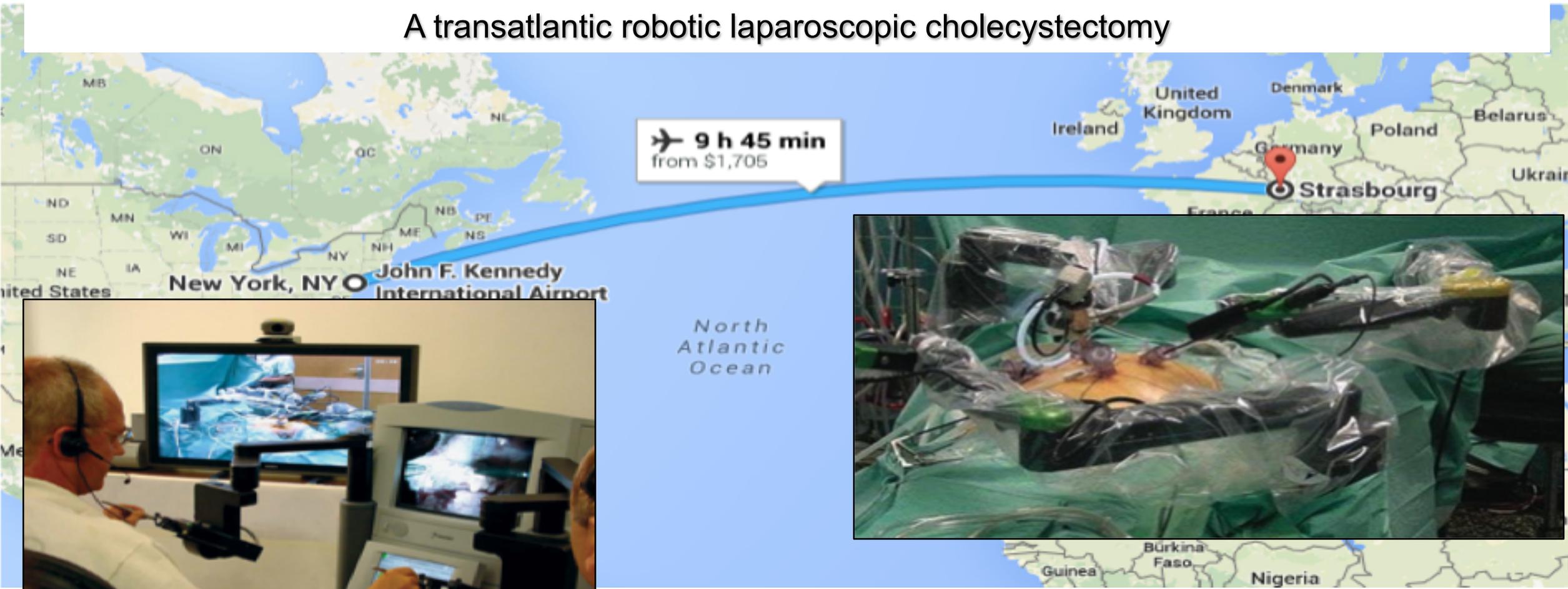
*The operation was carried out successfully in 54 minutes without difficulty or complications. Despite a round-trip distance of more than 14,000 km, the mean time lag for transmission during the procedure was 155 ms.*

# Transcontinental Robot-Assisted Remote Telesurgery: Feasibility and Potential Applications

Jacques Marescaux, MD, Joel Leroy, MD, Francesco Rubino, MD, Michelle Smith, MD, Michel Vix, MD, Michele Simone, MD, and Didier Mutter, MD

From the IRCAD-EITS (European Institute of Telesurgery), Louis Pasteur University, Strasbourg, France

## A transatlantic robotic laparoscopic cholecystectomy



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# Is Telestenting Even Feasible?

## The REMOTE-PCI Study

### **Percutaneous coronary intervention using a combination of robotics and telecommunications by an operator in a separate physical location from the patient: an early exploration into the feasibility of telestenting (the REMOTE-PCI study)**



Ryan D. Madder\*, MD; Stacie M. VanOosterhout, MEd; Mark E. Jacoby, MD; J. Stewart Collins, MD; Andrew S. Borgman, MS; Abbey N. Mulder, BSN, RN; Matthew A. Elmore, BA; Jessica L. Campbell; Richard F. McNamara, MD; David H. WOHNS, MD

*Frederik Meijer Heart & Vascular Institute, Spectrum Health, Grand Rapids, MI, USA*

#### KEYWORDS

- robotic percutaneous coronary intervention
- telemedicine
- telestenting

#### **Abstract**

**Aims:** The present study explores the feasibility of telestenting, wherein a physician operator performs stenting on a patient in a separate physical location using a combination of robotics and telecommunications.

**Methods and results:** Patients undergoing robotic stenting were eligible for inclusion. All manipulations of guidewires, balloons, and stents were performed robotically by a physician operator located in an isolated separate room outside the procedure room housing the patient. Communication between the operating physician and laboratory personnel was via telecommunication devices providing real-time audio and video connectivity. Among 20 patients who consented to participate, technical success, defined as success...

Madder et al EuroIntervention  
2017;12:1569-1576

A photograph of a hospital operating room. In the background, a person in blue scrubs is seated at a workstation with multiple monitors. The room is filled with medical equipment, including a large white machine on the right and various cables hanging from the ceiling. A blue callout box with white text is overlaid on the image, pointing to a tangled mass of black and white cables on the floor. The text inside the box reads "Still connected with cables".

Still connected  
with cables

# REMOTE-PCI: Primary Endpoints

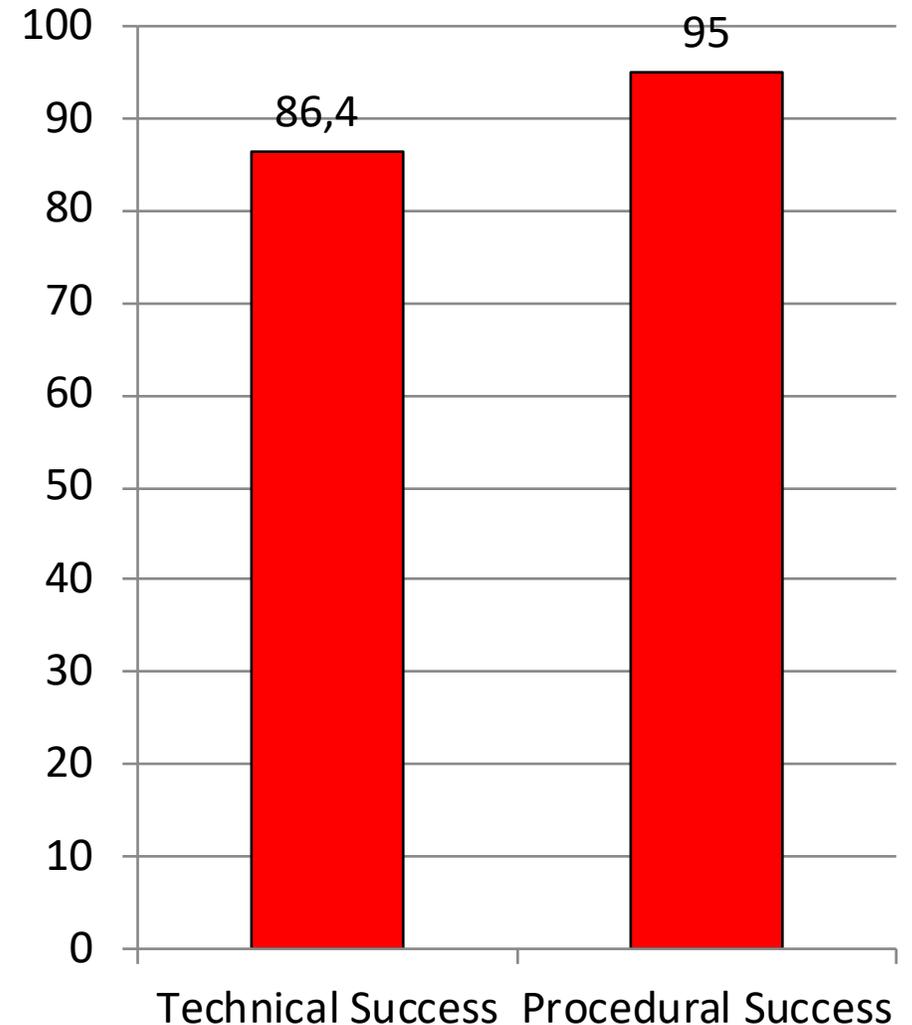
## *Pre-specified primary endpoints:*

### 1) Technical success

- successful intracoronary advancement and retraction of guidewires, angioplasty balloons, and stents by the robotic system without conversion to manual operation

### 2) Procedural success

- <30% residual stenosis upon completion of the procedure in the absence of death or repeat revascularisation prior to hospital discharge



# The Need for Robotics in the Cath Lab



## **Consistency & Reliability**

Reduce variability in operator skills and clinical outcomes  
(best clinical practices)



## **Access for all patients**

Medical care at all times at any [rural] location



## **Protection for Staff**

Physician and staff health concerns are rising as more evidence is generated on cath lab occupational hazards



**Improve  
patient  
care**



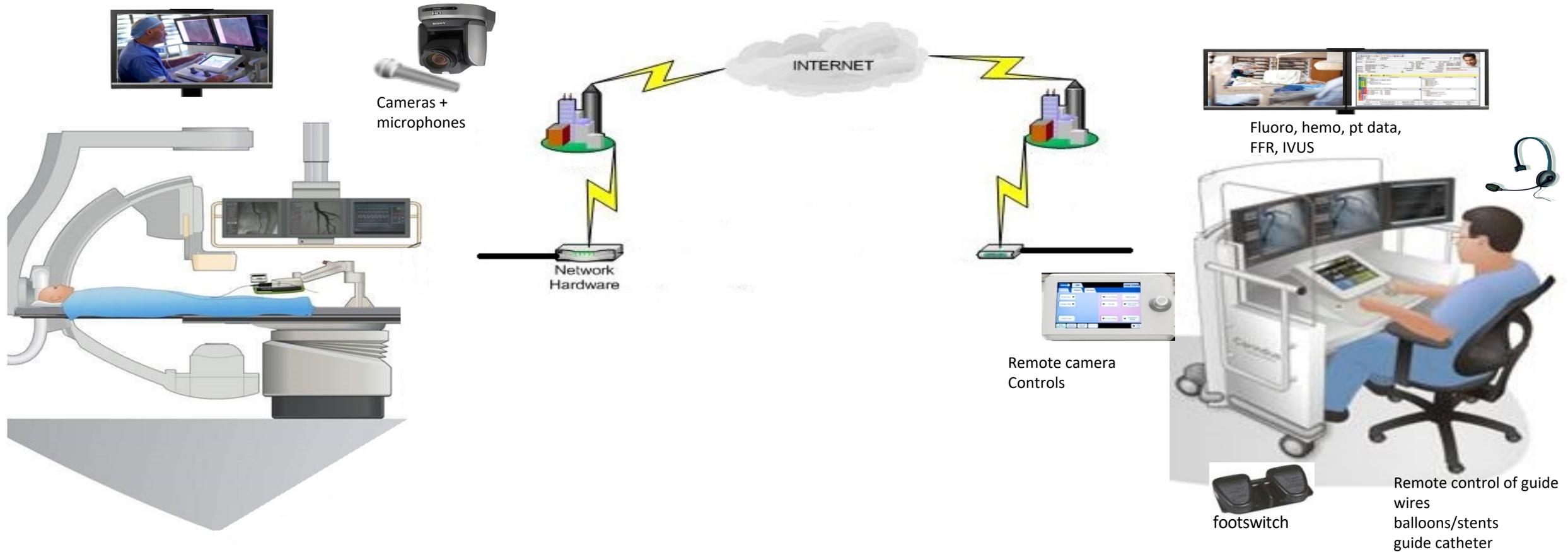
## Building a remote PCI

PI: Dr. M. Eleid

- Multi stage protocol
- Distancing the consul form the patient
- First case via intranet
- Building a cloud base interphase
- First over the cloud case



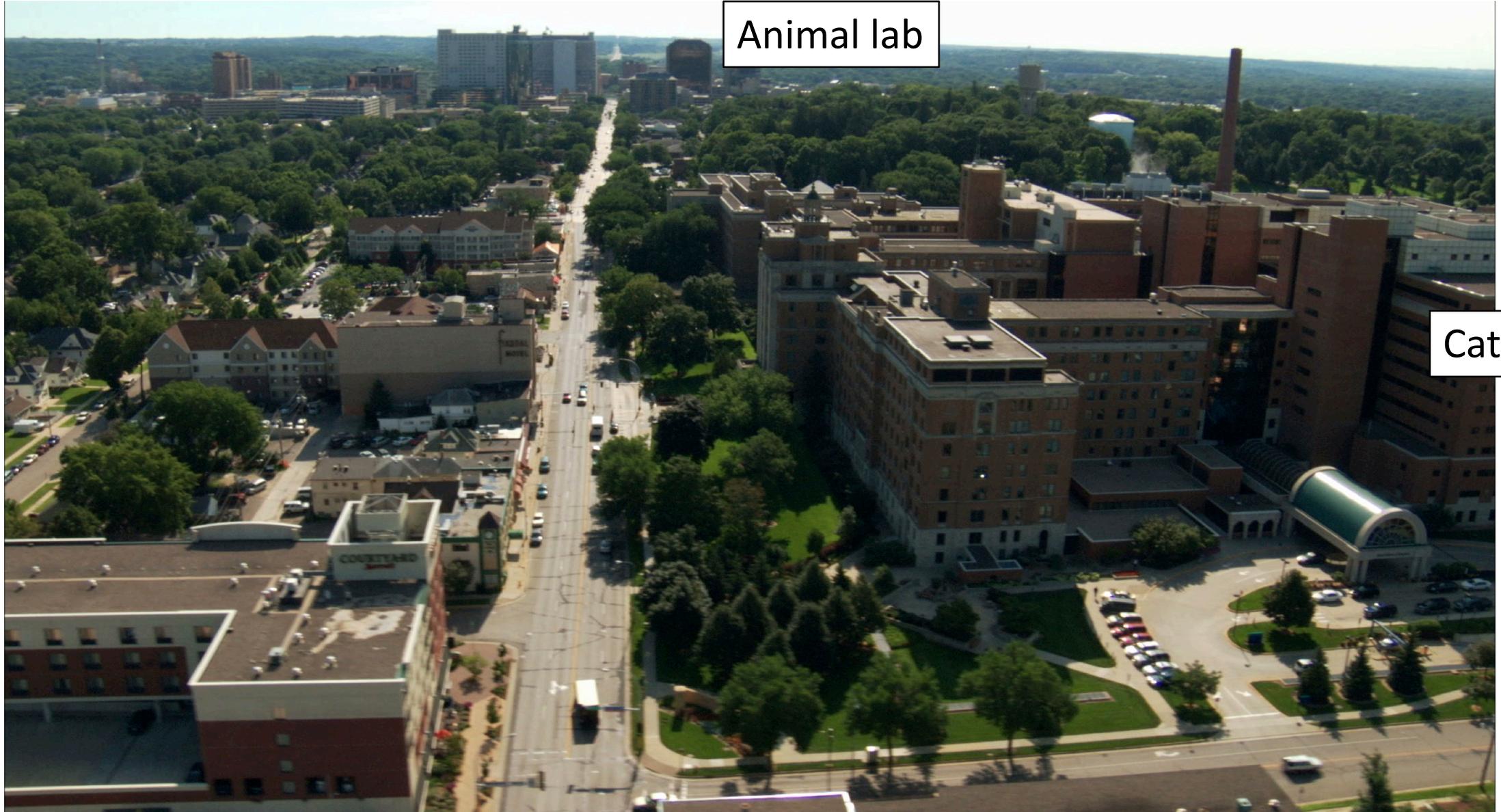
# Remote PCI



Cath lab – at the patient

Immerse IC virtually into the cath lab  
Education

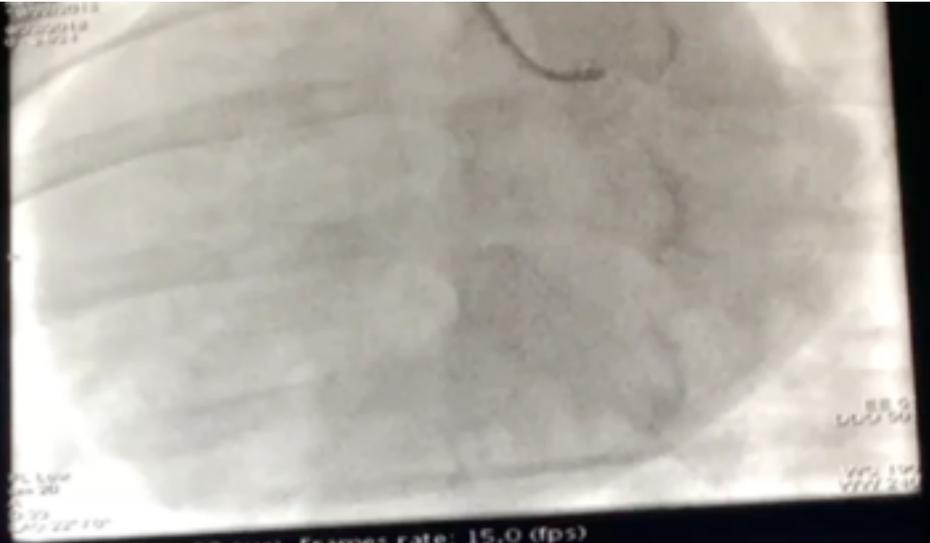
# *Live from TCT 2018*



Animal lab

Cath lab

5 AM



UP NEXT  
Martin  
30th An

Total Delay: 39 (ms), Frames rate: 15.0 (fps)



# Remote PCI

