

# Medical Cost and Prognostic Impact of FFR-guided PCI

Seung Hun Lee, MD, PhD<sup>1</sup>

David Hong, MD<sup>2</sup>, Joo Myung Lee, MD, MPH, PhD<sup>2</sup>;  
on the behalf of FRAME-AMI Investigators

<sup>1</sup>Chonnam National University Hospital, South Korea;

<sup>2</sup>Samsung Medical Center, South Korea

# Disclosure

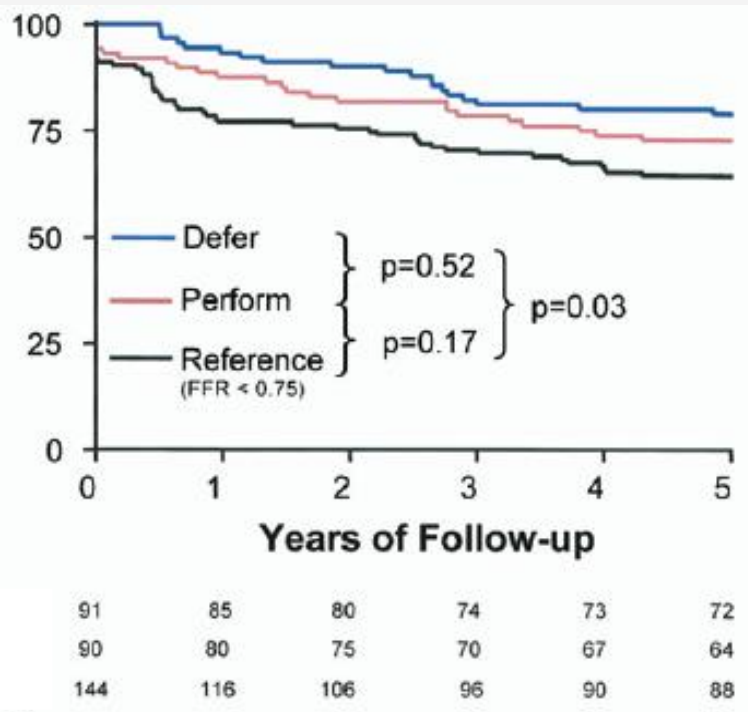
## Relationships with commercial interests:

- **Grants/Research Support: Abbott Korea, Abbott Vascular, Korean Cardiac Research Foundation**
- **Speakers Bureau/Honoraria: Abbott Vascular, Boston Scientific, Medtronic, MicroPort**
- **Consulting Fees: Dotter**
- **Other: None**

# Clinical Benefit of Physiology-Guided PCI

## DEFER

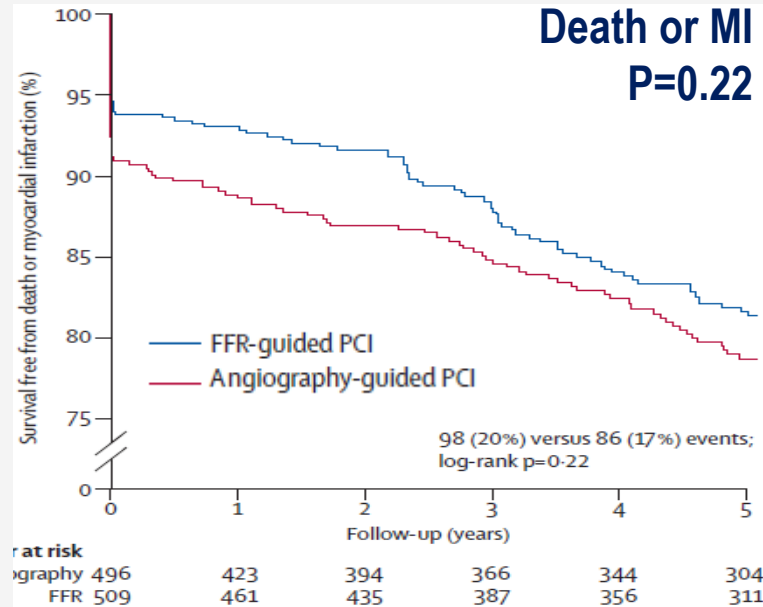
Defer vs. PCI in FFR $\geq$ 0.75



Safety of deferral of PCI based on negative FFR

## FAME

Angio- vs. FFR-guided PCI in MVD

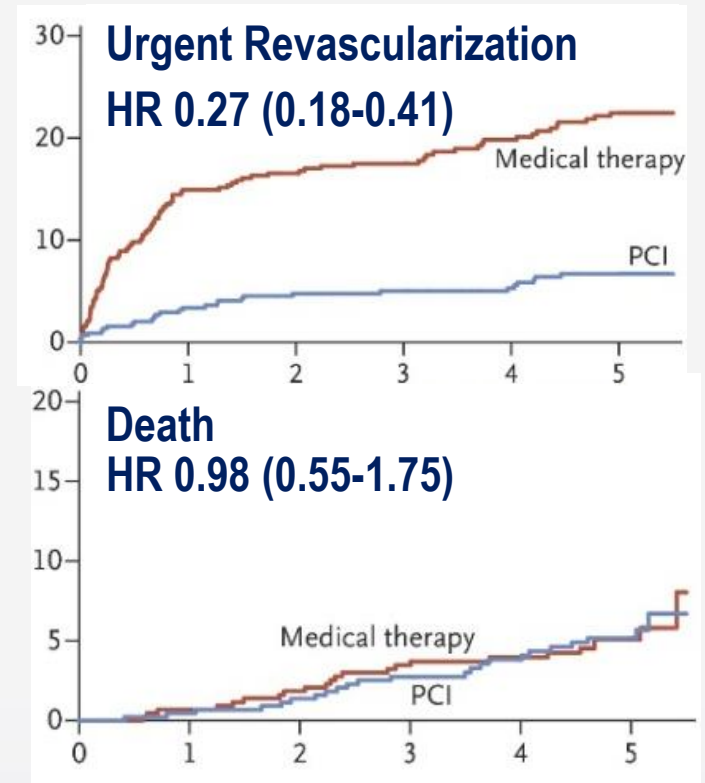


No. Stents: 2.7 vs. 1.9, P<0.001

Long-term safety of FFR-guided PCI with lower cost

## FAME2

Medical Tx. vs. PCI in FFR $\leq$ 0.80



PCI was beneficial with lesions with positive FFR

# Current Status of Coronary Physiology to Guide PCI

## 2018 ESC Guideline for Myocardial Revascularization

Recommendations	Class <sup>a</sup>	Level <sup>b</sup>
When evidence of ischaemia is not available, FFR or iwFR are recommended to assess the haemodynamic relevance of intermediate-grade stenosis. <sup>15,17,18,39</sup>	I	A

## 2021 ACC/AHA/SCAI Coronary Revascularization Guideline

COR	LOE	RECOMMENDATIONS
1	A	1. In patients with angina or an anginal equivalent, undocumented ischemia, and angiographically intermediate stenoses, the use of fractional flow reserve (FFR) or instantaneous wave-free ratio (iFR) is recommended to guide the decision to proceed with PCI (1-6).
3: No benefit	B-R	2. In stable patients with angiographically intermediate stenoses and FFR >0.80 or iFR >0.89, PCI should not be performed (7-10).

Both guidelines have recommended the FFR-guided decision making as Class IA.

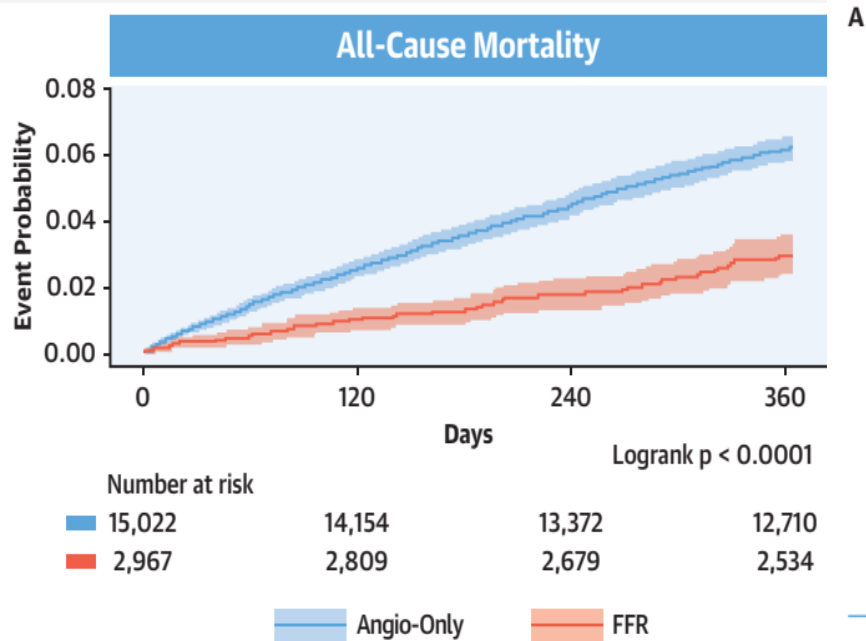
**What about real-world data and adoption rate?**

# FFR-guided PCI improve patient survival in nationwide cohort studies

## All-Cause Mortality

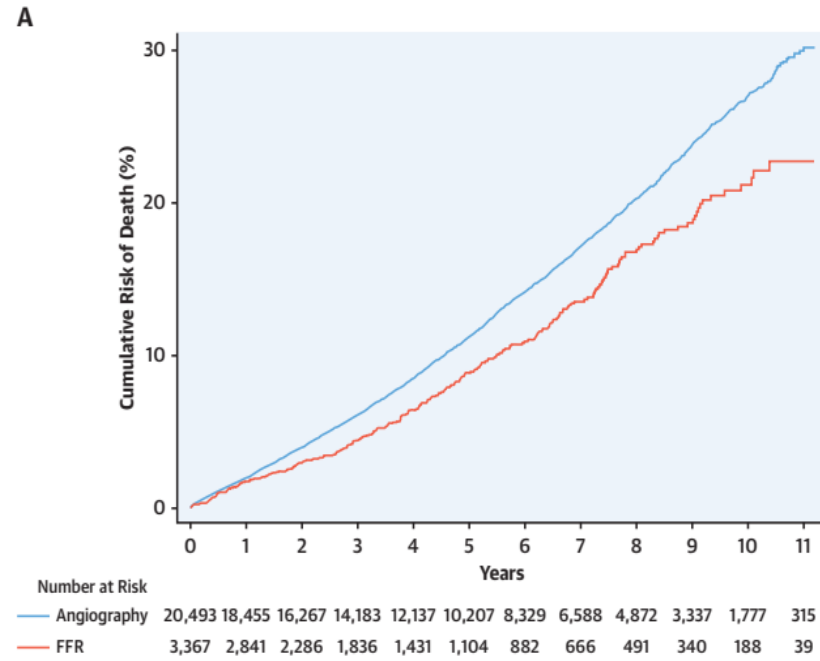
### FFR-Guided PCI versus Angiography-Only PCI

#### USA



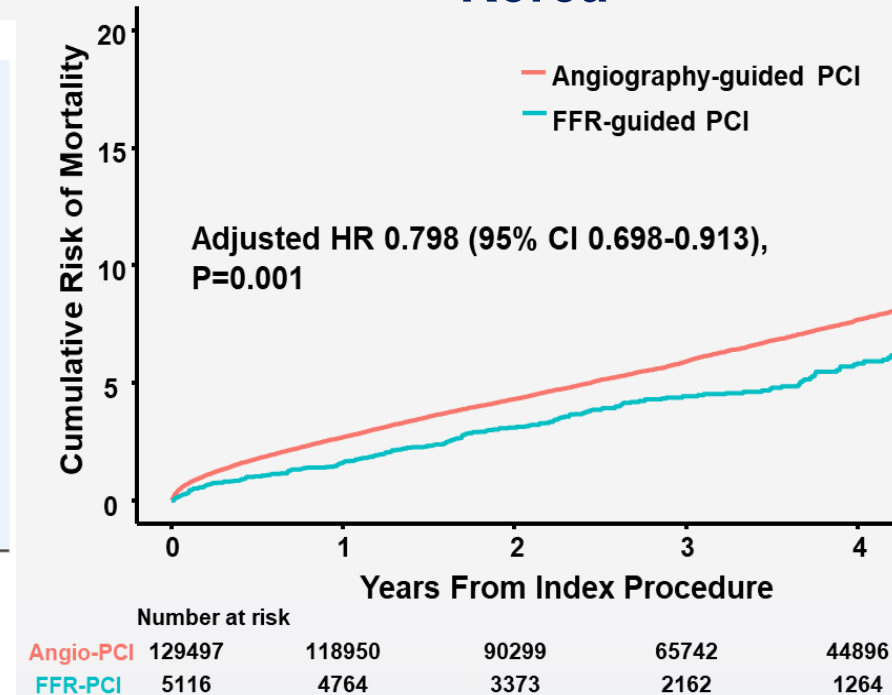
**Veterans Affairs registry 2009-2017**  
(Stable IHD N=17,989, 1 Year)

#### Europe (Sweden)



**SCAAR registry 2005-2016**  
(Stable IHD N=23,860, Median 4.7 Years)

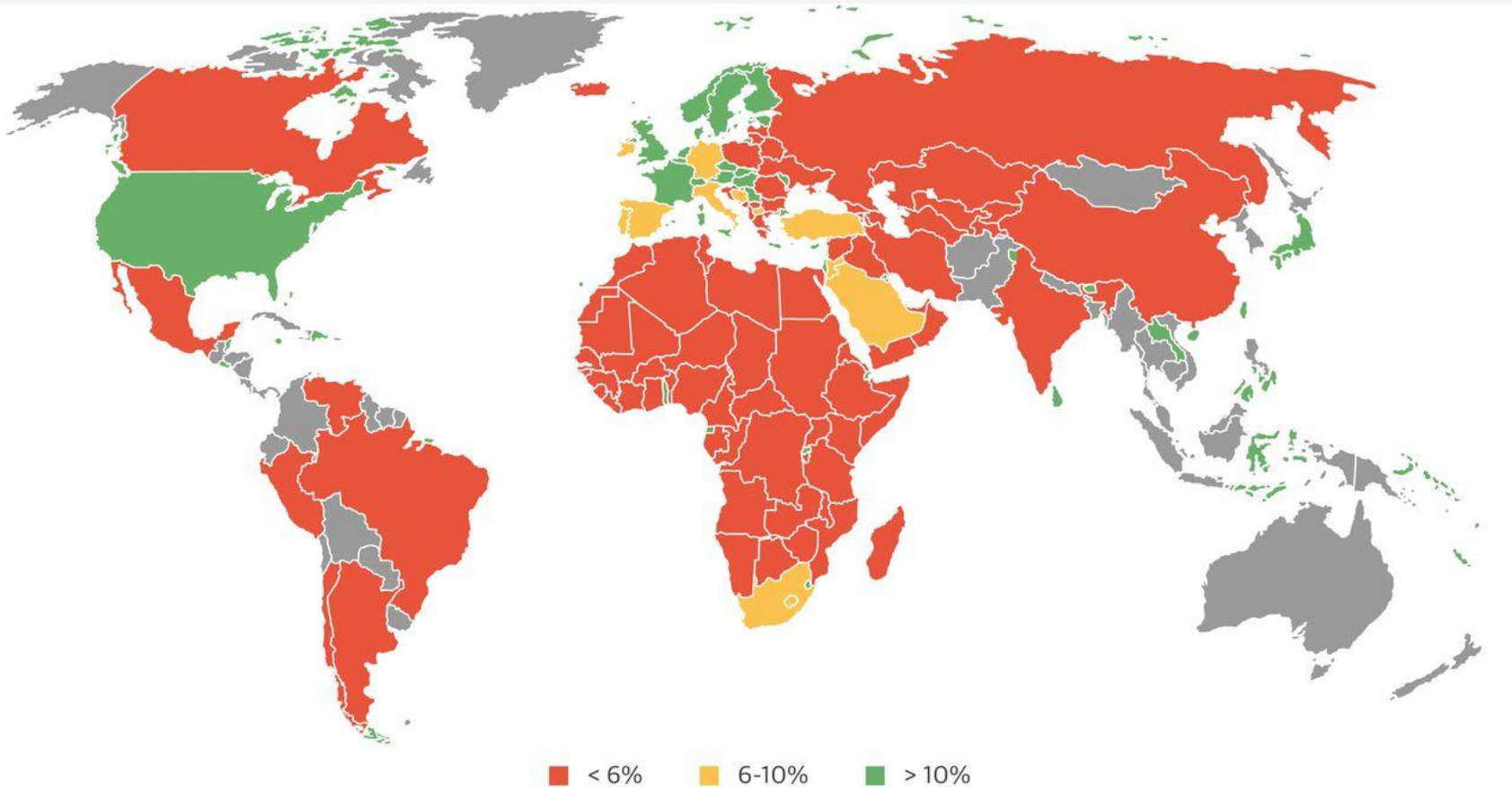
#### Korea



**Korean NHIS-HIRA 2013-2018**  
(Total N=134,613, 4 Years)

# Low Adoption Rate of FFR in Contemporary Practice

*Experts emphasized the role of FFR.  
Guidelines endorsed Class IA.  
RWDs showed reductions in mortality.*



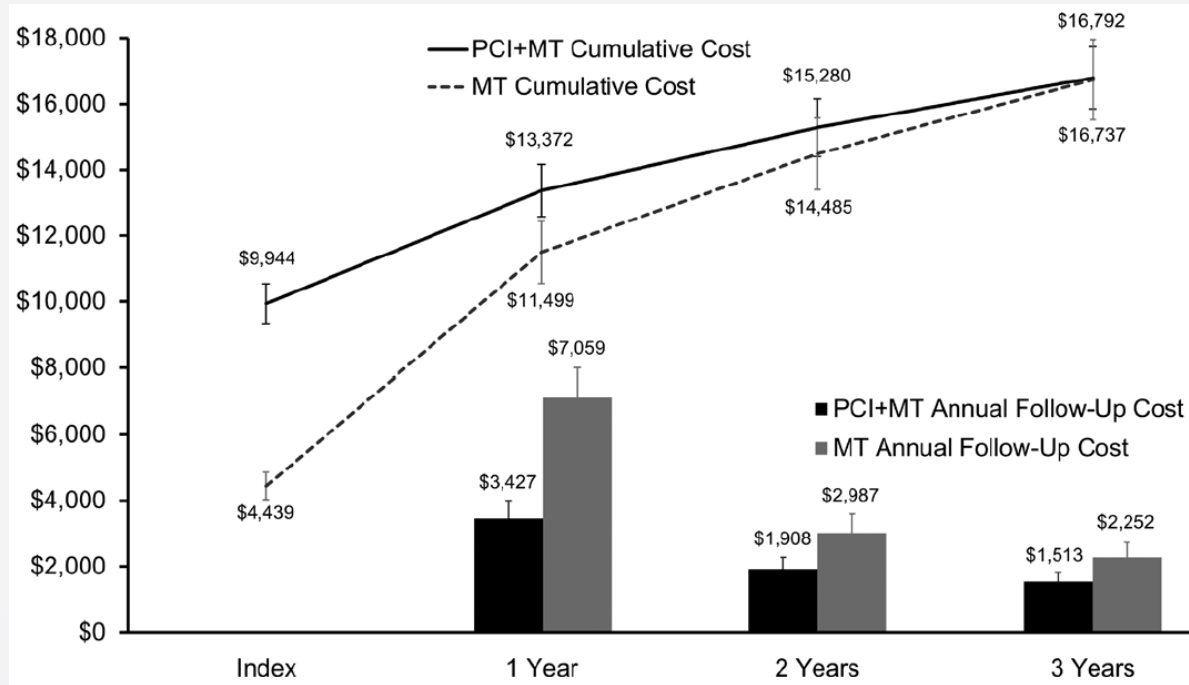
**Multifactorial reasons for limited adoption rates.**

Whether FFR can reduce

- 1. Cost-Effectiveness**
2. Additional procedural time
3. Knowledge Barrier
4. Physician attitude remains questionable...

# Cost-Effectiveness of FFR-Guided PCI

## Patients with FFR<0.80 from FAME2 3-Year Cumulative Medical Costs



Mean initial costs were higher in the PCI group, but by 3 years were similar between the 2 groups.

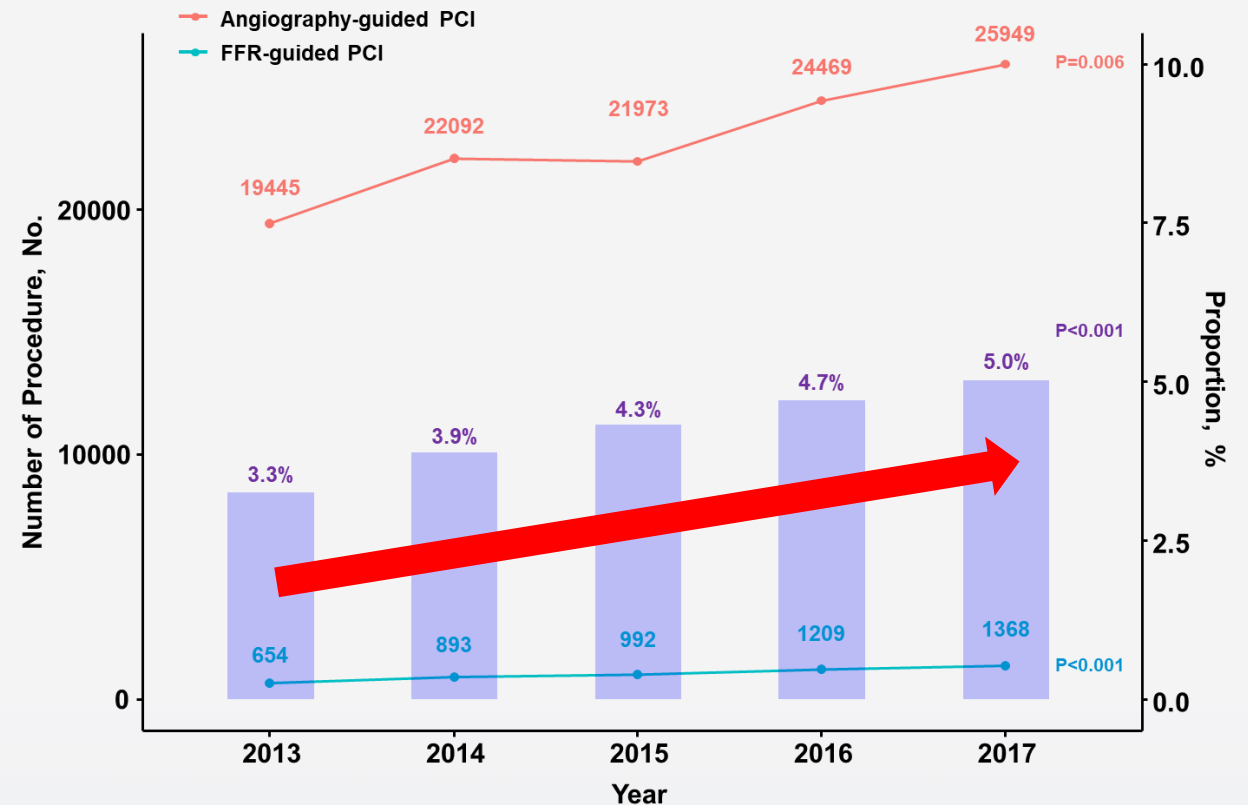
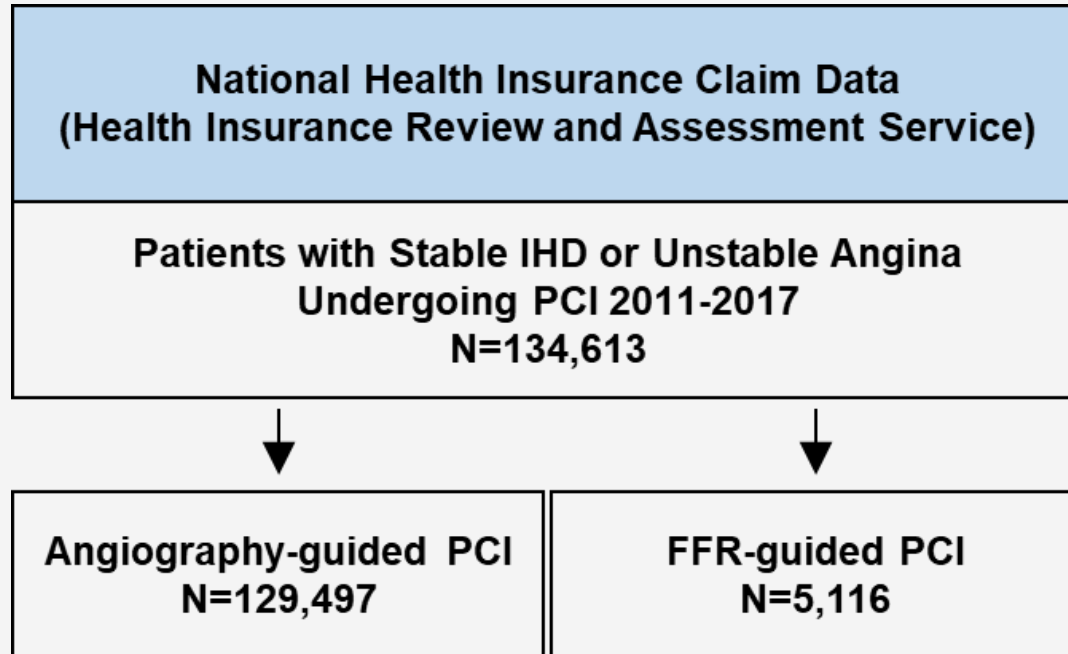
## Decision Tree Model of SIHD undergoing ICA from Multicenter-Registry 3-Month Cumulative Medical Costs

	Angiography-guided group	FFR-guided group	Difference
<b>Test cost</b>			
Angiography	54,000	54,000	0
FFR	0	185,660	185,660
<b>Treatment cost</b>			
CABG	99,792	90,455	-9337
PCI	995,497	522,485	-473,012
Medical treatment	189,983	362,066	172,083
<b>Total medical cost</b>	<b>1,339,272</b>	<b>1,214,666</b>	<b>-124,606</b>

# Real-world Data of FFR-guided PCI in Korea

## Health Insurance Review and Assessment Service Data

134,613 Patients with Stable and Unstable Angina (2011~2017)



Although the **annual number** and **proportion of FFR-guided PCI** significantly increased, **only 3.8% were FFR-guided PCI** in Korea.

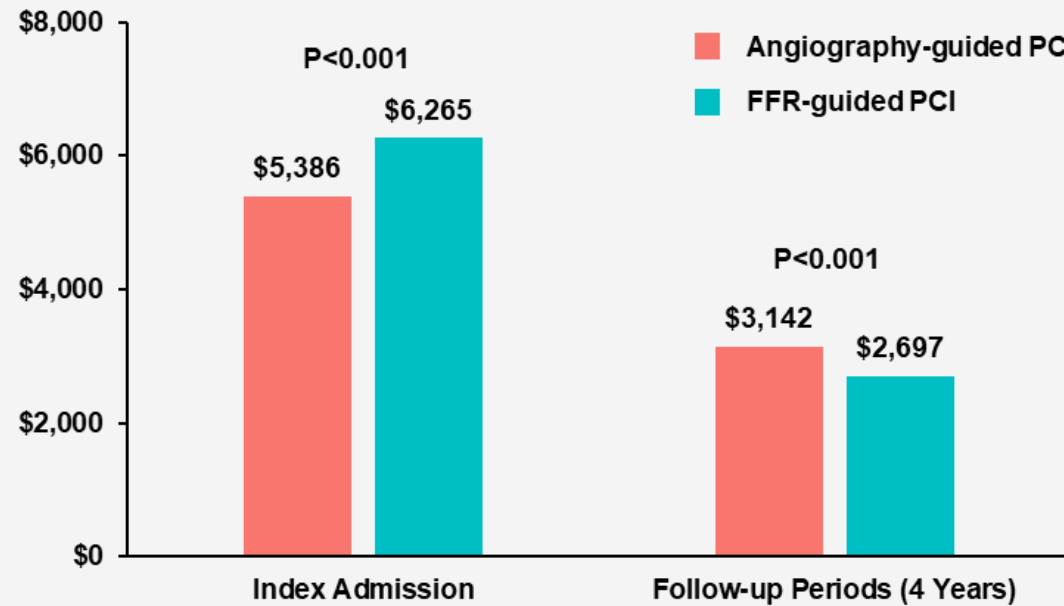


# Real-world Data of FFR-guided PCI in Korea

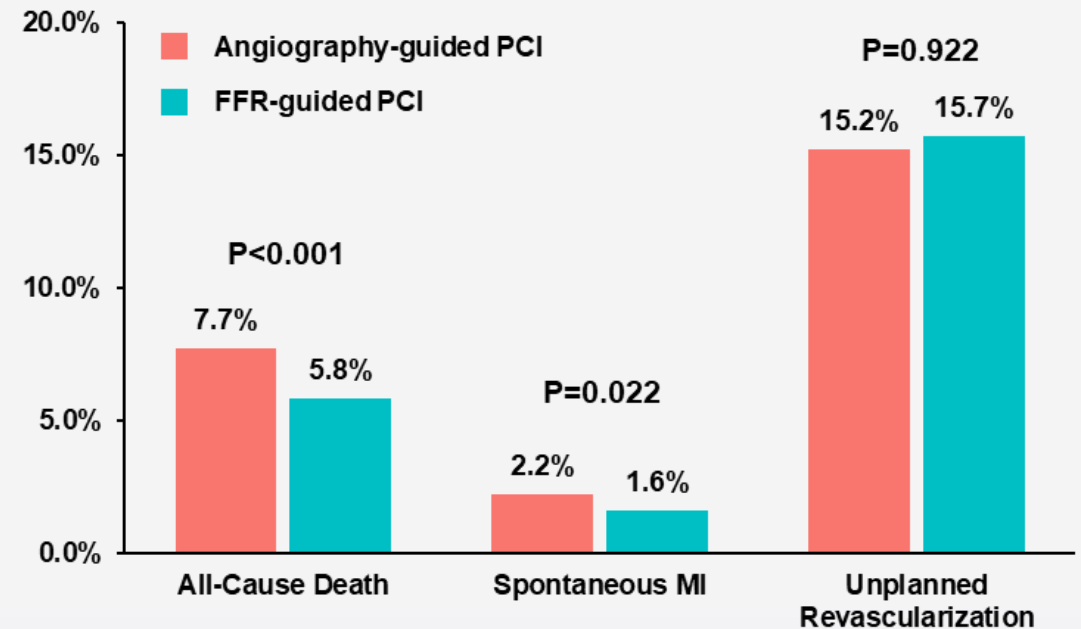
## Health Insurance Review and Assessment Service Data

134,613 Patients with Stable and Unstable Angina (2011~2017)

### Medical Costs



### Adverse Clinical Events



- FFR-guided PCI showed significantly lower risk of **all-cause death** or **spontaneous MI** at 4 years.
- Although FFR group showed higher medical cost during index admission, cumulative medical cost after index admission was significantly lower in the FFR group.

# Cost-Effectiveness Analysis with Nationwide Data

## 1. Patient-Level Analysis (Korea)

National Health Insurance Claim Data  
(Health Insurance Review and Assessment Service)

**Patients with Stable or Unstable Angina**  
Undergoing PCI 2011-2017  
N=134,613

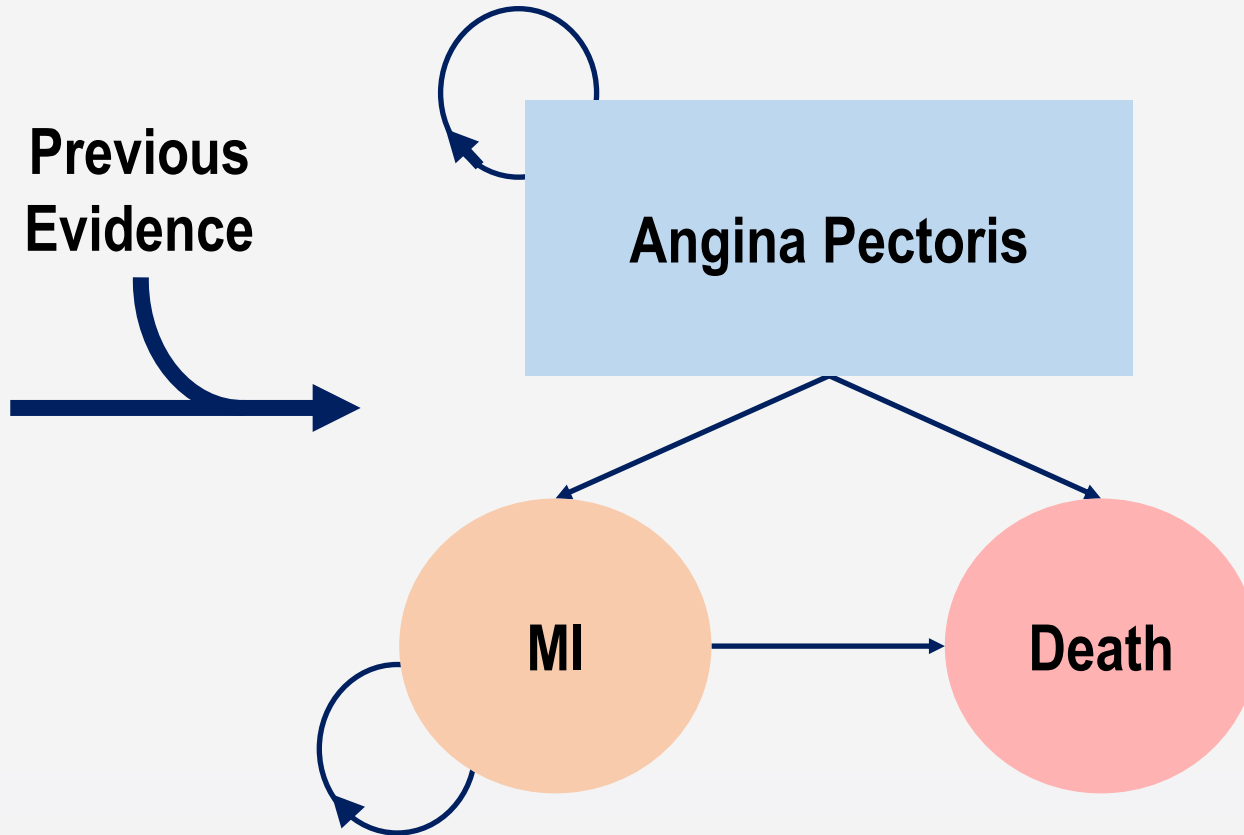
Angiography-guided PCI  
N=129,497

FFR-guided PCI  
N=5,116

### Outcomes

- Cost
- Quality-adjusted life year (QALY):  $\sum (\text{Utility of each status} \times \text{Time in each status})$
- Incremental cost-effectiveness ratio (ICER) =  $\Delta\text{QALY} / \Delta \text{Cost}$

## 2. Markov Model-Based Analysis (Korea, US, UK)



# Cost-Effectiveness Analysis with Nationwide Data

## Patient-Level: Cost-Effectiveness Analysis at 4-Year (Korea)

Base-Case Analysis	Cost, \$		QALYs		Cost-Effectiveness ICER(US\$/QALY)
	Total	Incremental	Total	Incremental	
Angio-PCI	10,503	Reference	3.037	Reference	<b>-7,748</b>
<b>FFR-PCI</b>	10,200	<b>-303</b>	3.076	<b>0.039</b>	

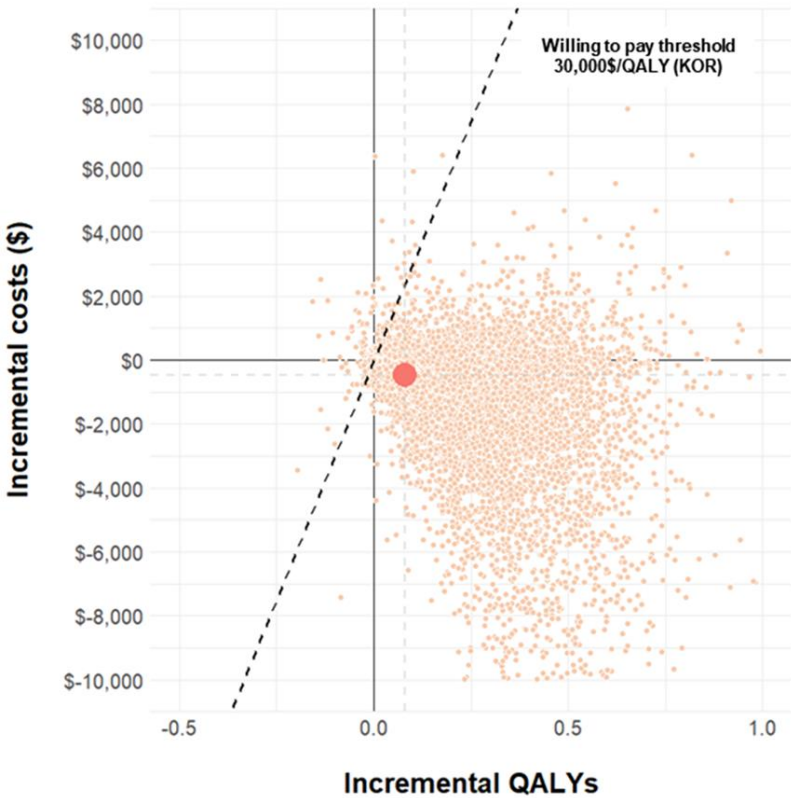
FFR-based PCI was shown to achieve **better quality of life at lower cost** compared to angiography-based PCI.

# Cost-Effectiveness Analysis with Nationwide Data

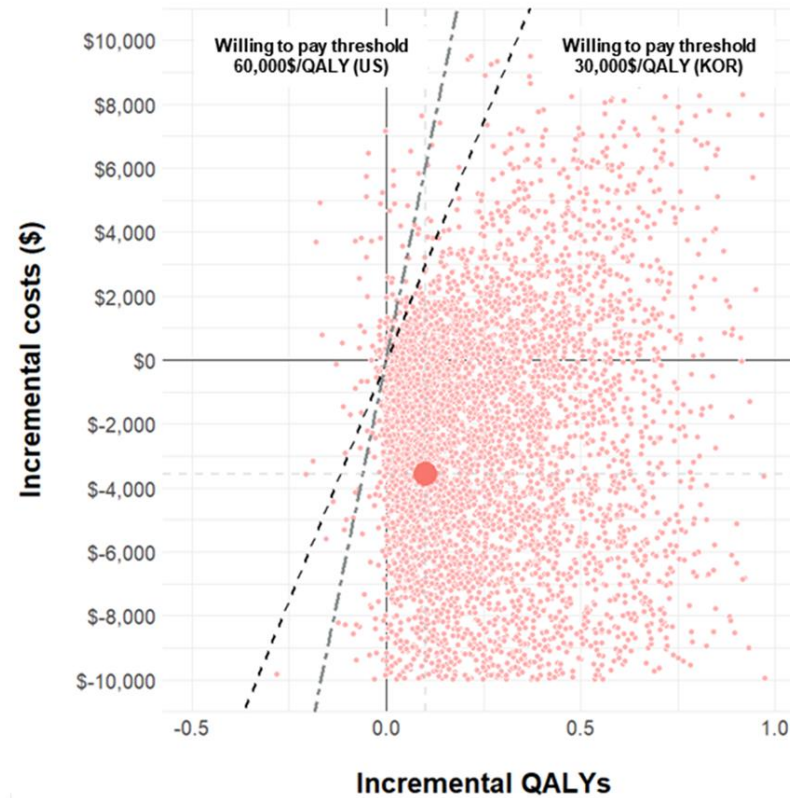
## Model-Based: Probabilistic Sensitivity Analysis (PSA)

Bootstrap Technique with 25,000 Replications

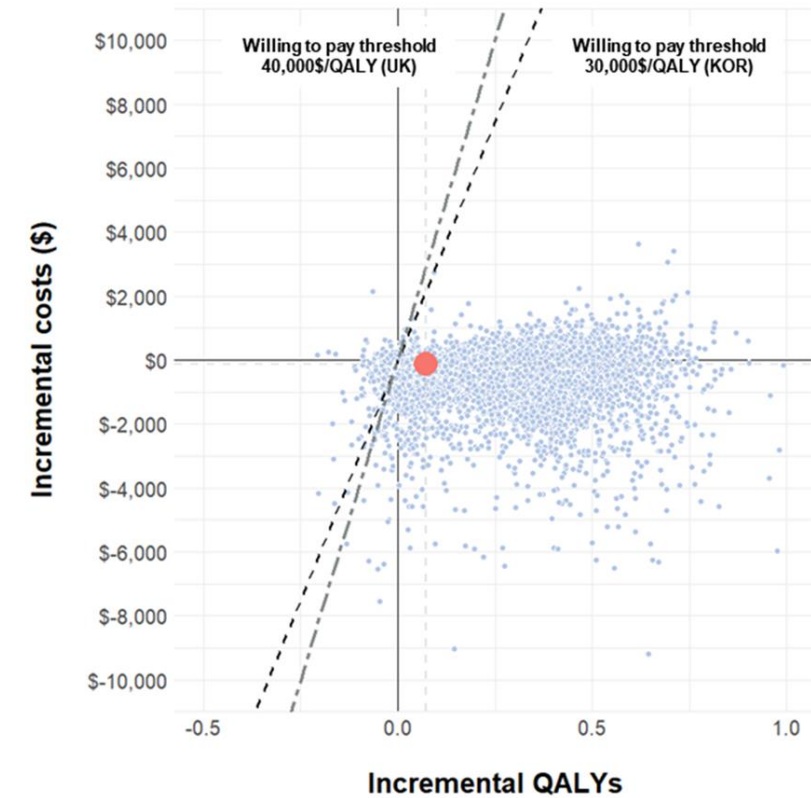
Korea



US



UK



Given the GDP per capita in each country, cost-effectiveness for FFR-based PCI were **93.5%, 92.3% and 90.8%** for Korea, US and UK in PSA analysis, respectively.

# FFR-guided vs. Angio-guided PCI for Non-IRA Lesions

## FLOWER-MI Trial

Prospective, Multi-center, Open-Label Randomized Trial  
1171 MV-STEMI Patients from 41 French Centers

**Primary Endpoint: all-cause death,  
nonfatal MI (+ preprocedural MI), revascularization**

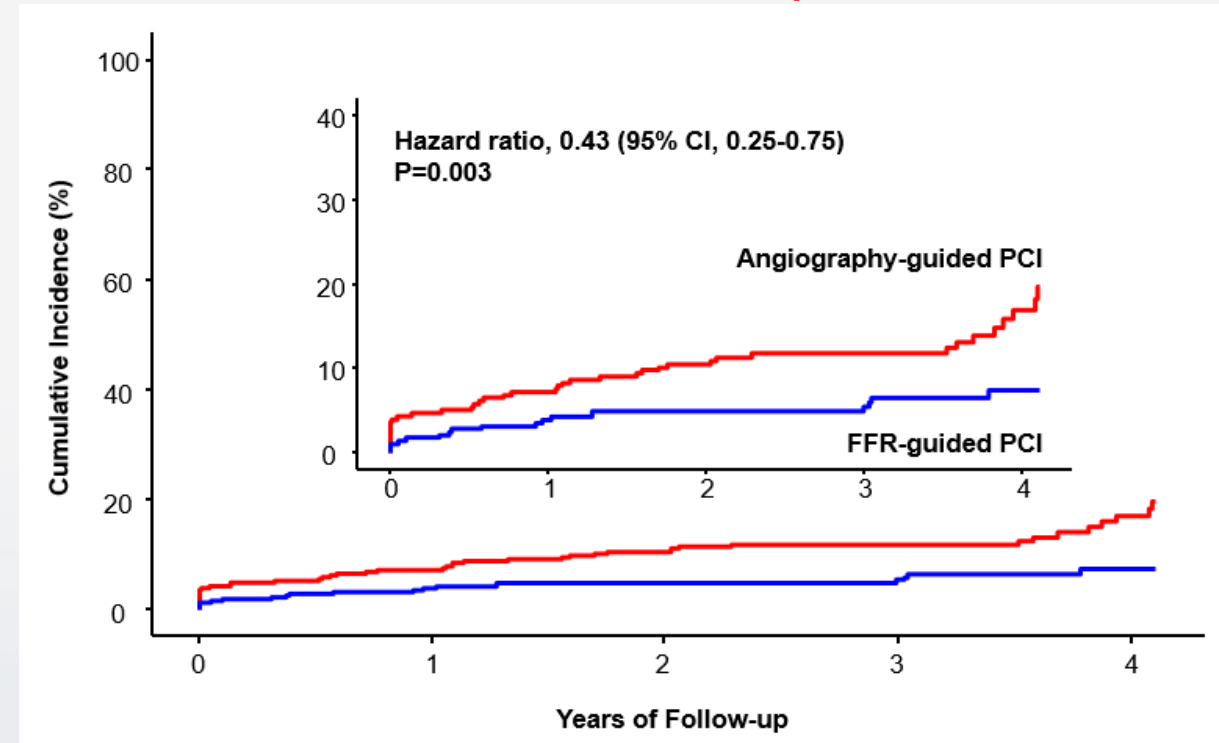
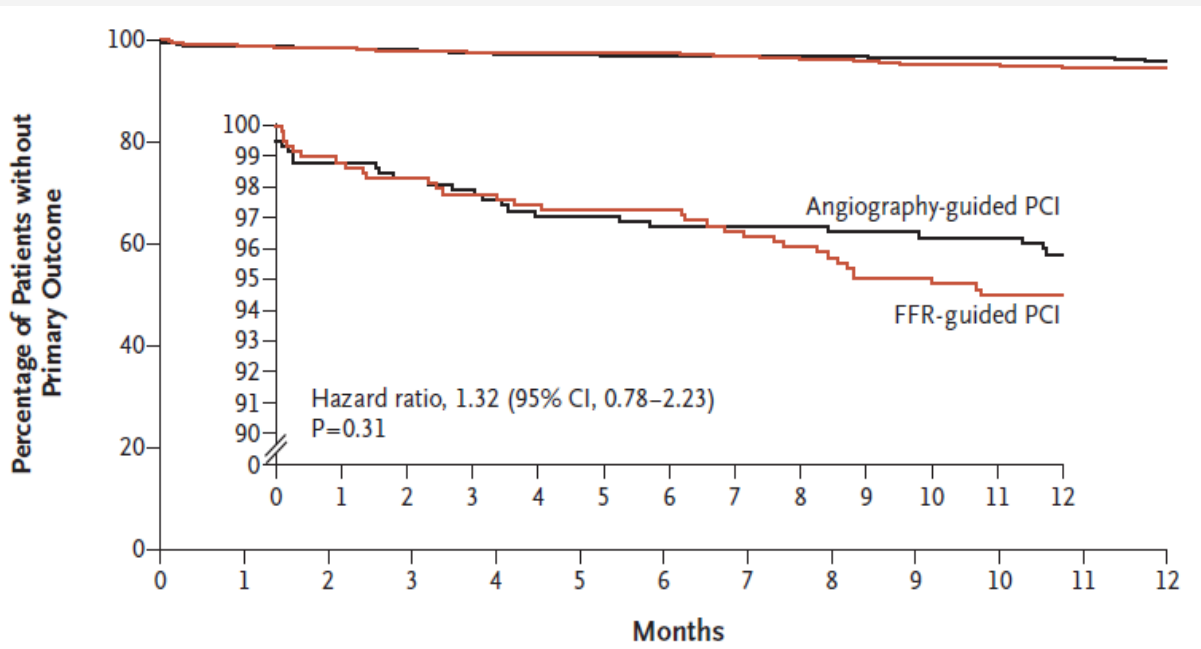
**FFR 5.5% vs. Angiography 4.2% at 1 Year  
96.2% staged PCI**

## FRAME-AMI Trial

Prospective, Multi-center, Open-Label Randomized Trial  
562 MV-AMI Patients from 14 Korean Centers

**Primary Endpoint: all-cause death,  
nonfatal MI (+ preprocedural MI), revascularization**

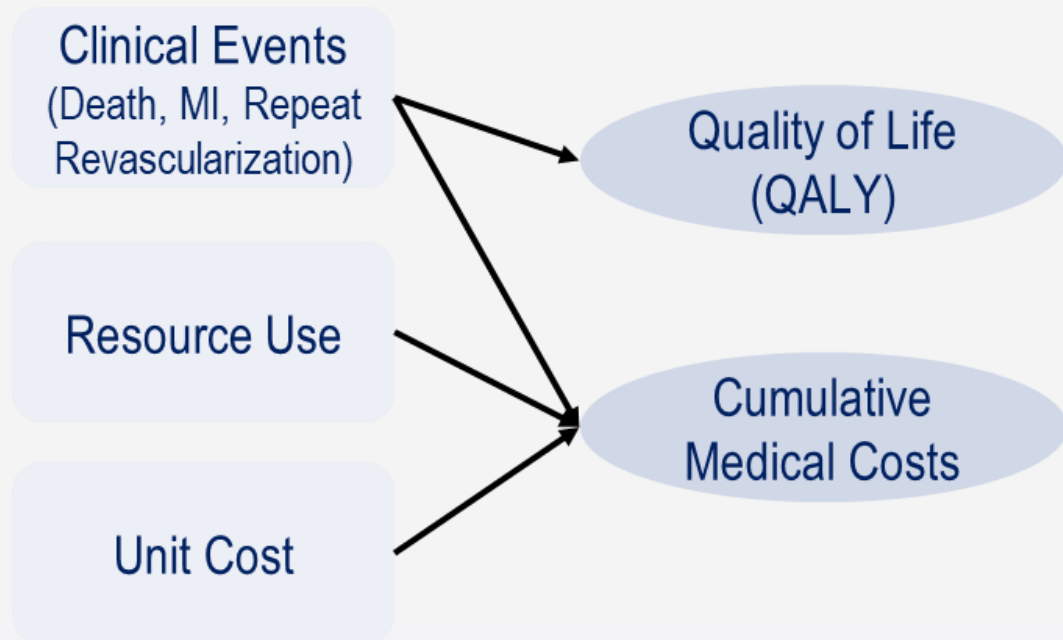
**FFR 7.4% vs. Angiography 19.7% at 3.5 Years  
60.0% immediate non-culprit PCI**



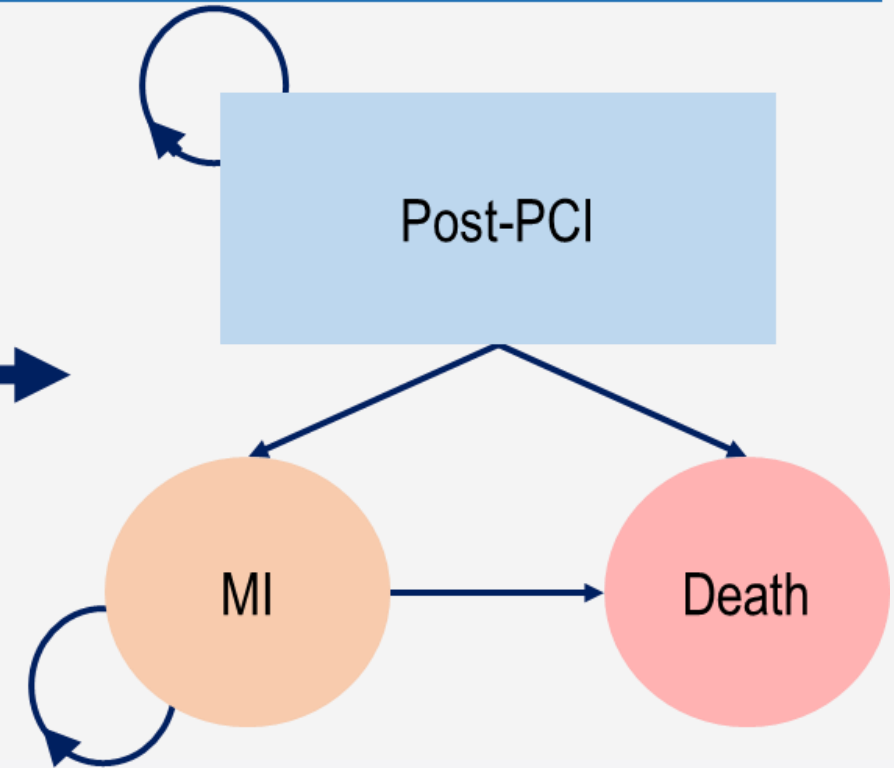
# Cost-Effectiveness Analysis of FFR-guided PCI in AMI and MVD

## 1. Patient-Level Analysis

### FRAME-AMI Trial



## 2. Markov Model-Based Analysis (Korea, US, EU)



### Main Outcomes:

- **Cost:** Cumulative medical cost, excluding non-medical, indirect costs
- **Quality-adjusted life year (QALY):**  $\sum (\text{Utility of each status} \times \text{Time in each status})$
- **Incremental cost-effectiveness ratio (ICER)** =  $\Delta \text{Cost} / \Delta \text{QALY}$
- **Incremental net monetary benefit (INB)** =  $\text{INB} = (\Delta \text{QALY} \times \text{willingness to pay}) - \Delta \text{Cost}$

# Cost-Effectiveness Analysis of FFR-guided PCI in AMI and MVD

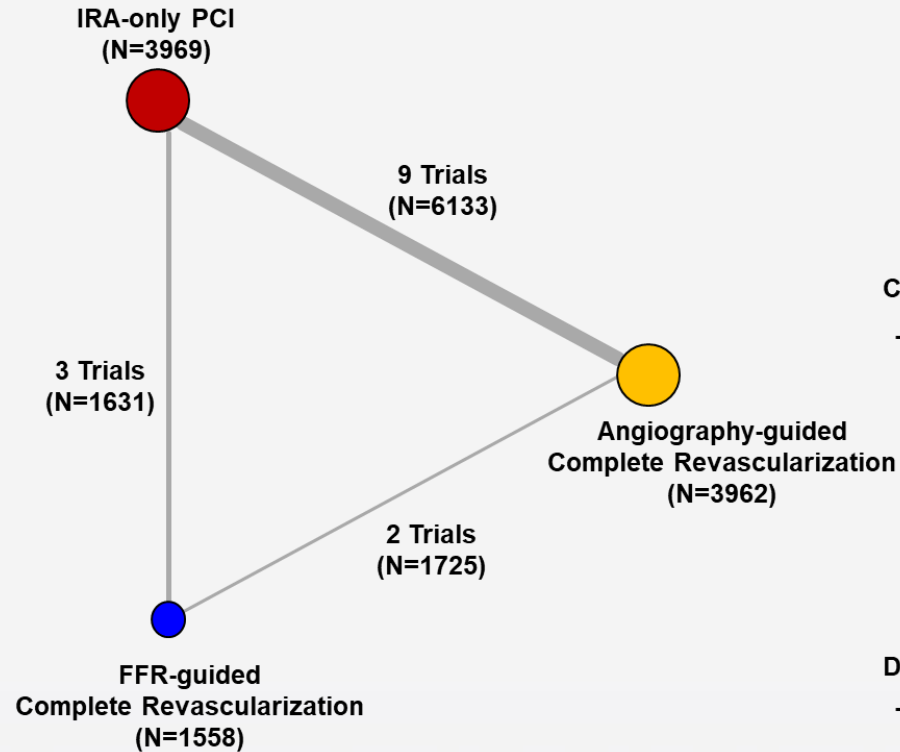
## Key Inputs in the Model

	Korean population		US population		EU population	
	Value	Source	Value	Source	Value	Source
<b>Cost*</b>						
<b>Medical cost at index hospitalization</b>						
Angio-guided PCI	9,842	FRAME-AMI	14,878	FAME	7,226	FLOWER-MI
FFR-guided PCI	9,326	FRAME-AMI	13,182	FAME	7,647	FLOWER-MI
Unit cost per service/product, \$						
Performance fee for IRA PCI	2,126	FRAME-AMI	2,005	FAME 2	202	FLOWER-MI
Performance fee for immediate non-IRA PCI	435	FRAME-AMI	796	FAME 2	202	FLOWER-MI
Performance fee for staged non-IRA PCI	1,357	FRAME-AMI	567	Fearon WF et al.	194	FLOWER-MI
DES, 1EA	1,431	FRAME-AMI	1,656	Fearon WF et al.	613	FLOWER-MI
Pressure wire	709	FRAME-AMI	650	FAME	428	FLOWER-MI
Guidewire	16	FRAME-AMI	85	FAME	50	FLOWER-MI
Intensive care unit cost per day	74	FRAME-AMI	2,877	FAME	346-863	FLOWER-MI
Hospitalization cost per day	15	FRAME-AMI	2,000	FAME	578-820	FLOWER-MI
<b>Medical cost at event</b>						
Death from any cause	9,235	HOST-EXAM	35,818	Kazi DS et al.	1,586	FLOWER-MI
Non-fatal MI	7,338	HOST-EXAM	16,544	FAME	5,370	FLOWER-MI
Repeat revascularization	7,292	HOST-EXAM	12,780	FAME	4,633	FLOWER-MI
<b>Utility</b>						
After PCI	0.79	Kodera S et al.	0.92	COURAGE	0.85	Pocock S et al.
Recurrent MI (disutility)	-0.06	VALIANT	-0.06	VALIANT	-0.06	VALIANT

# Cost-Effectiveness Analysis of FFR-guided PCI in AMI and MVD

## Meta-Analysis for Transition Probabilities

A. Network Plot



B. Death

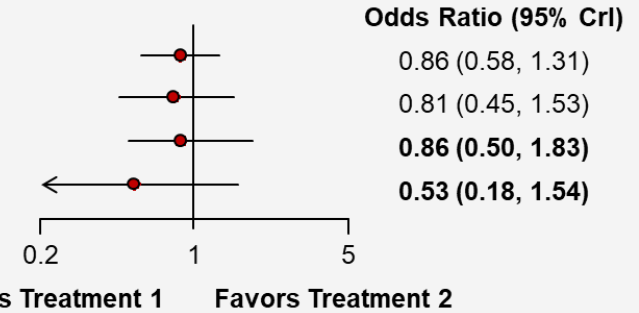
Treatment 1 vs. Treatment 2

Angio-PCI vs. IRA-only

FFR-PCI vs. IRA-only

FFR-PCI vs. Angio-PCI (Network)

FFR-PCI vs. Angio-PCI (Pairwise)



C. Myocardial Infarction

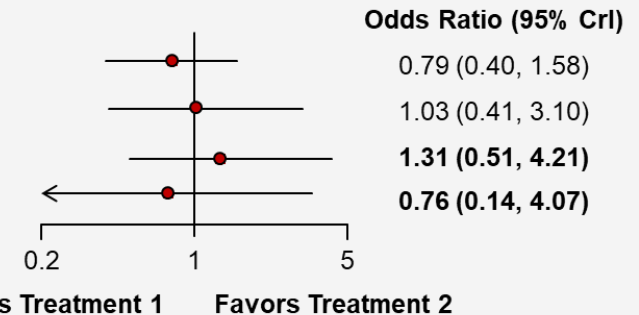
Treatment 1 vs. Treatment 2

Angio-PCI vs. IRA-only

FFR-PCI vs. IRA-only

FFR-PCI vs. Angio-PCI (Network)

FFR-PCI vs. Angio-PCI (Pairwise)



D. Repeat Revascularization

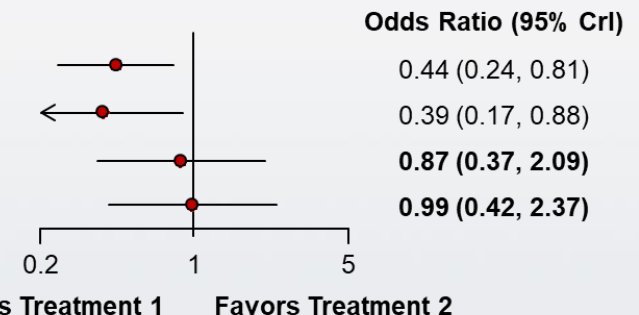
Treatment 1 vs. Treatment 2

Angio-PCI vs. IRA-only

FFR-PCI vs. IRA-only

FFR-PCI vs. Angio-PCI (Network)

FFR-PCI vs. Angio-PCI (Pairwise)





# Cost-Effectiveness Analysis of FFR-guided PCI in AMI and MVD

## Patient-Level: Cost-Effectiveness of FFR-Guided PCI (4 Year)

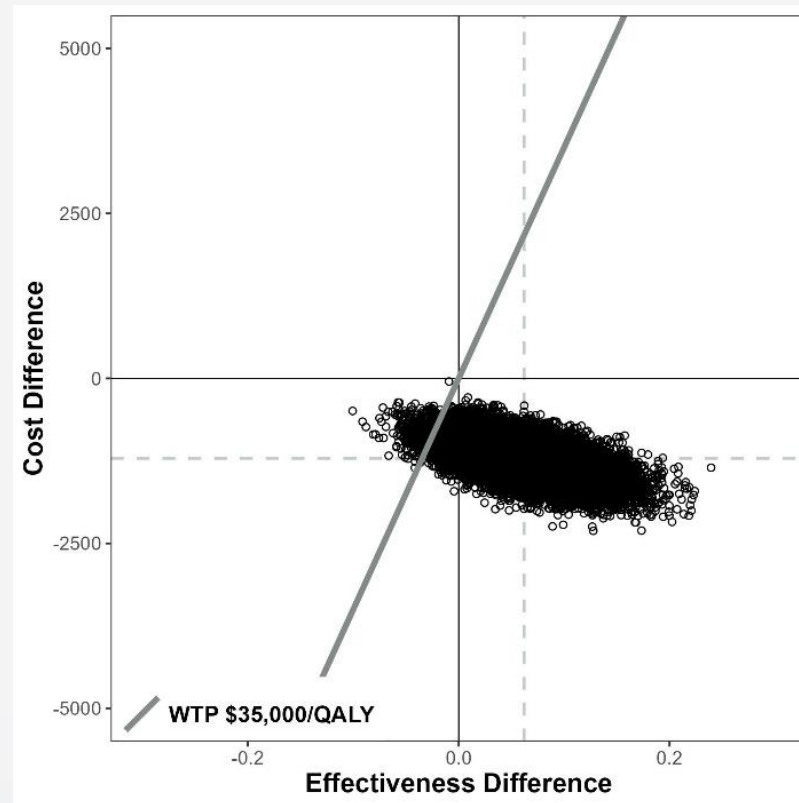
	Cost, \$		QALYs		Cost-Effectiveness	Incremental Net Monetary Benefit (\$)
	Total	Incremental	Total	Incremental	ICER (\$/QALY)	
<b>Utilities estimated from data</b>						
Angiography-guided PCI	11,057	Reference	3.40	Reference		
FFR-guided PCI	<b>9,849</b>	<b>-1,208</b>	<b>3.46</b>	<b>0.062</b>	<b>-19,484</b>	<b>3,378</b>
<b>Utilities extrapolated</b>						
Angiography-guided PCI	11,057	Reference	3.12	Reference		
FFR-guided PCI	<b>9,849</b>	<b>-1,208</b>	<b>3.21</b>	<b>0.087</b>	<b>-13,885</b>	<b>4,253</b>

**FFR-guided PCI was a more cost-effective treatment than the angiography-guided PCI**

# Cost-Effectiveness Analysis of FFR-guided PCI in AMI and MVD

## Model-Based: Probabilistic Sensitivity Analysis (PSA)

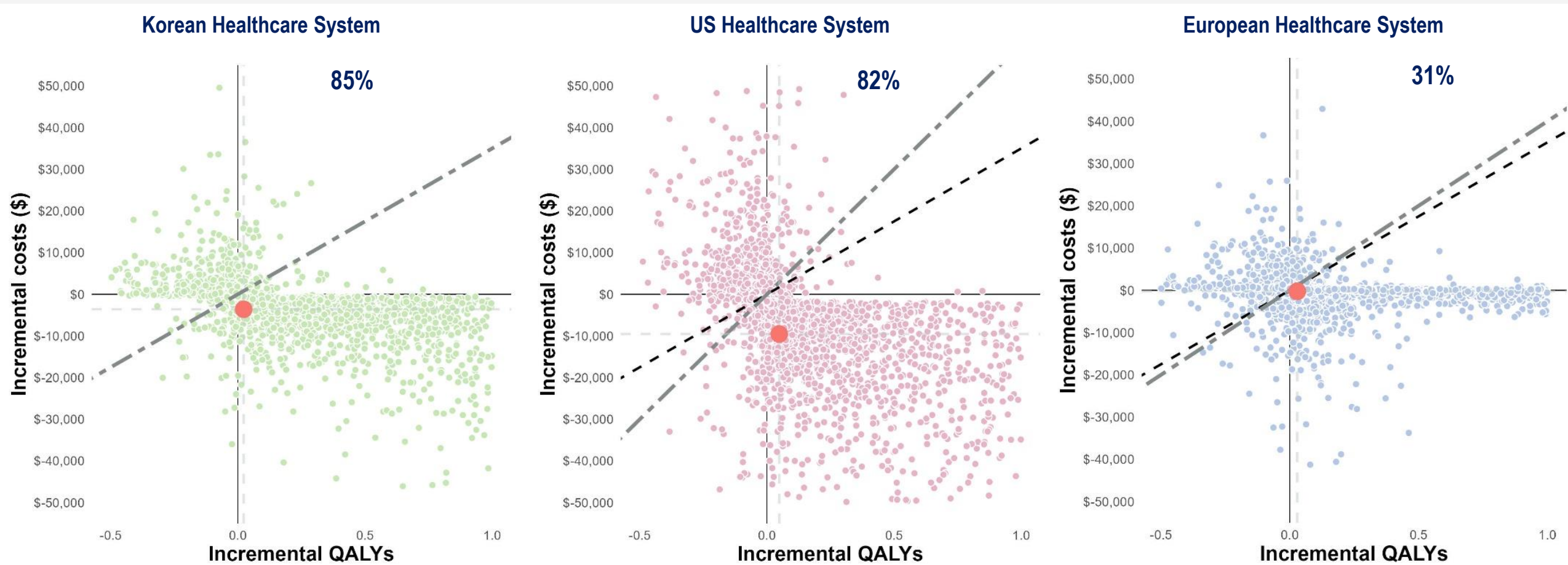
Bootstrap Technique with 25,000 Replications



According to Willingness-to-pay threshold based on GDP per capita,  
**FFR-based decision making was cost-effective in 97%.**

# Cost-Effectiveness Analysis of FFR-guided PCI in AMI and MVD

## Cost-Effectiveness of FFR-Guided PCI in 3 Different Healthcare Systems Probabilistic Sensitivity Analysis (PSA)



**FFR-guided PCI was a more cost-effective across Korea, USA, and Europe.**

# Conclusion

- **FFR-guided PCI continuously showed clinical benefit and cost-effective strategy among patients with stable ischemic heart disease.**
- **FFR-guided PCI for Non-IRA lesions in AMI patients has been tested compared with angiography-guided PCI, and two RCTs (FLOWER-MI and FRAME-AMI) showed inconclusive results.**
- **CEA of FFR-guided PCI in the FRAME-AMI study showed that the FFR-guided strategy was a more cost-effective approach for AMI patients with MVD.**