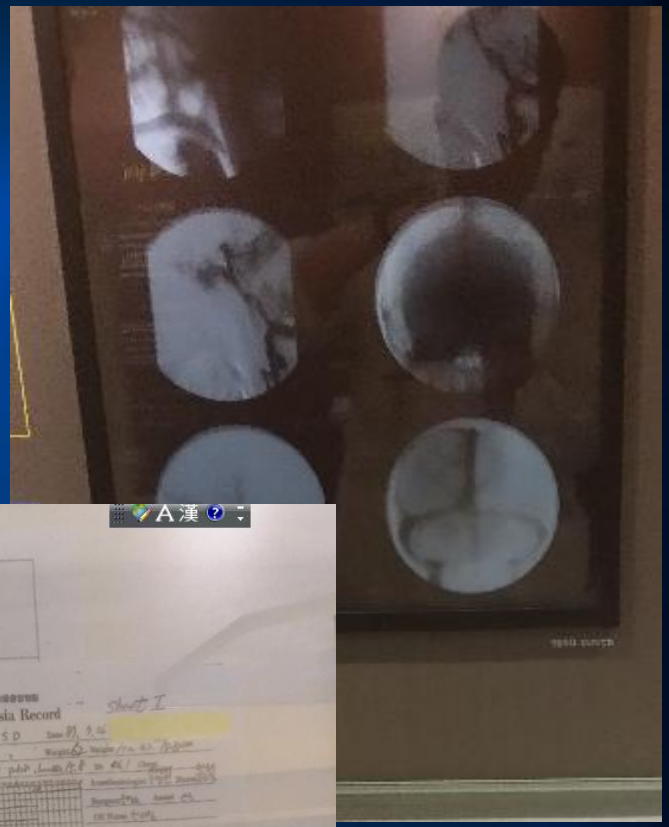
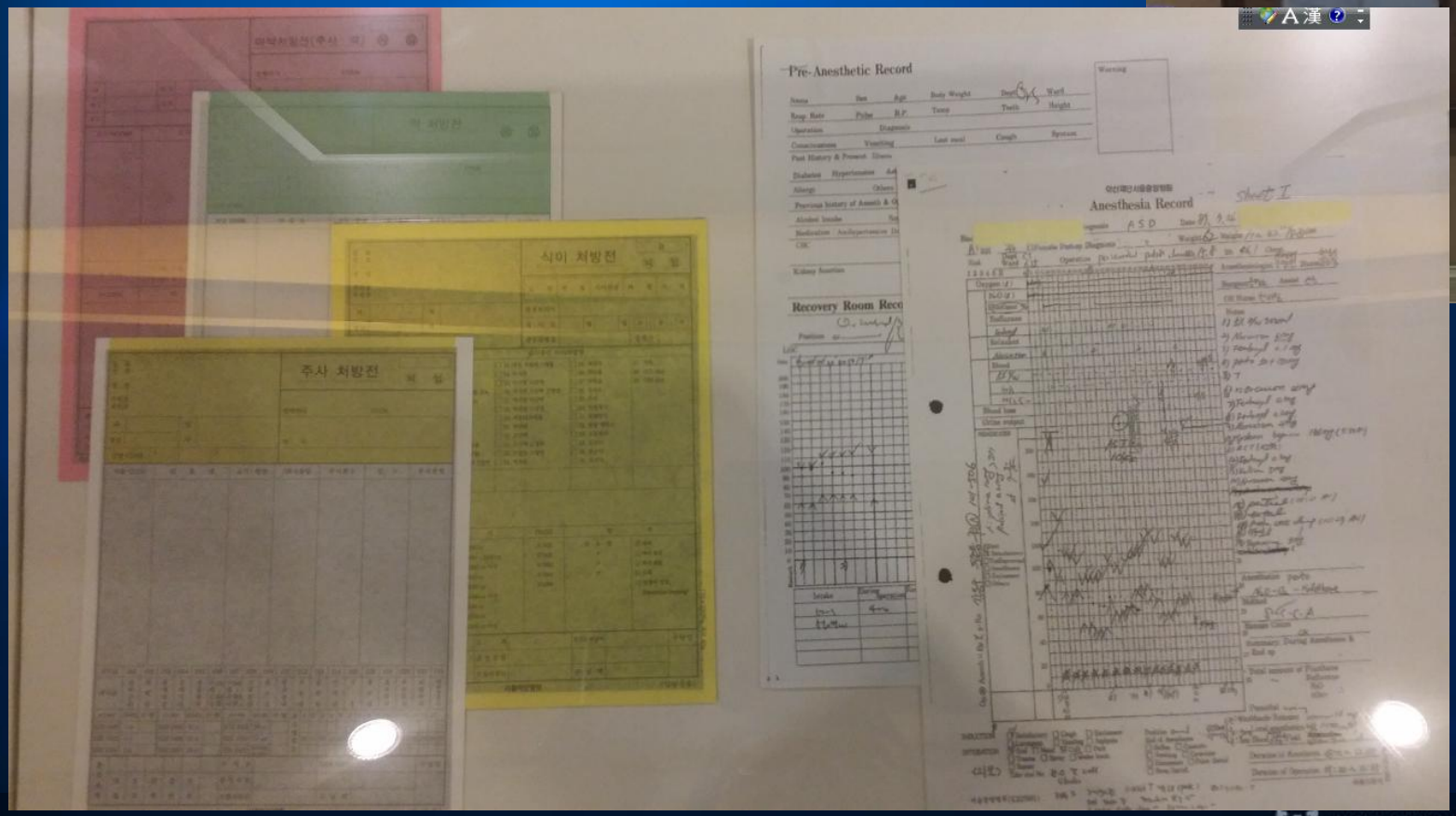
Utilization of Medical Bid Data for Cardiovascular Healthcare

University of Ulsan College of Medicine,
Asan Medical Center, Cardiology Division

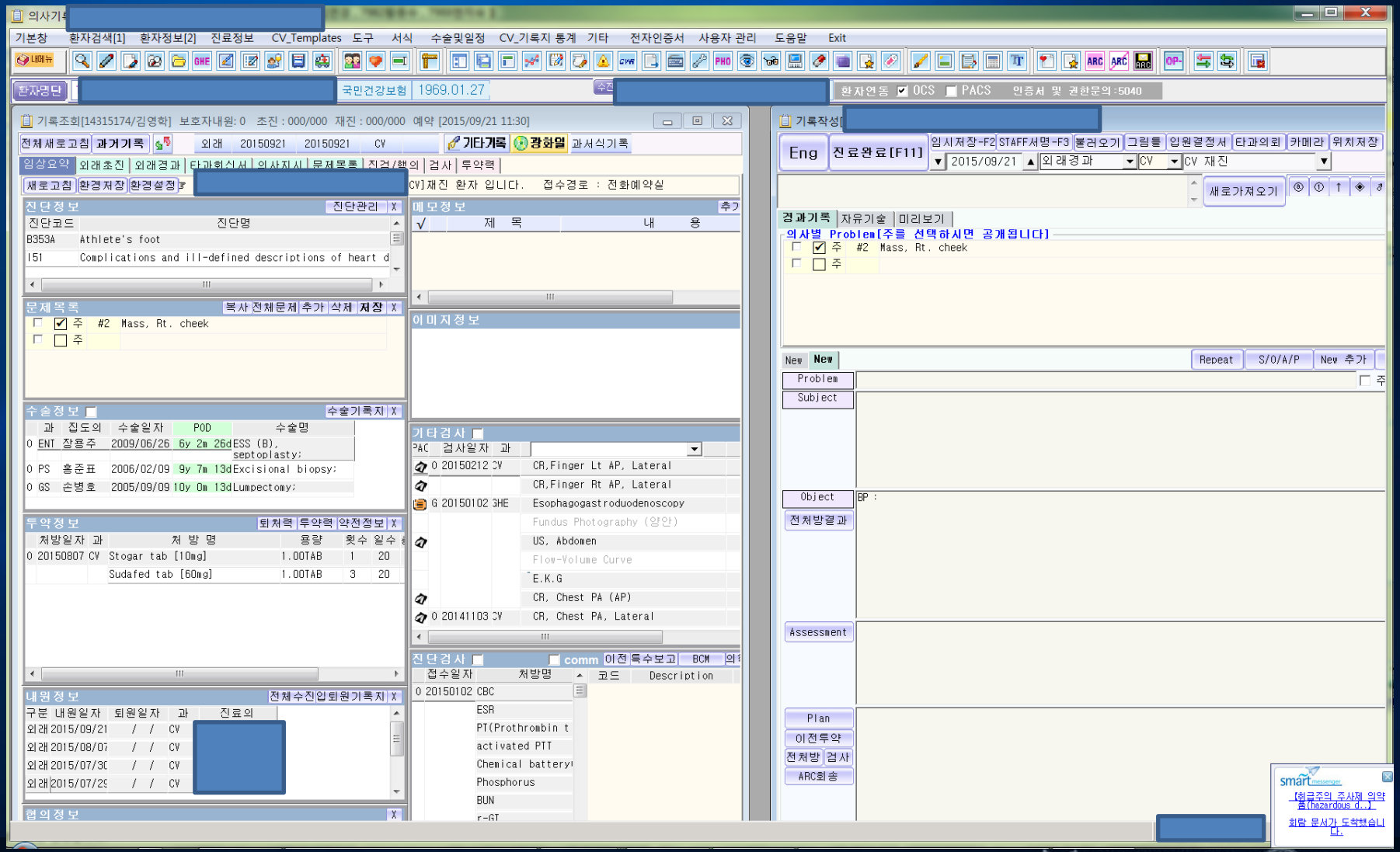
Young-Hak Kim, MD, PhD

Papers and Films 25 years ago in AMC when I was a resident





Electronic Medical Record (EMR)



Medical Big Data : 3V or 4V

- **Volume**
  - 150 exabytes (10^{18}) in 2011 USA

    (5 exabyte contain all the words ever spoken by human beings on earth)

- **Velocity**
  - Zeta bytes (10^{21}) maybe now

- **Variety**
  - Structured, unstructured, semi-structured

- **Veracity**
  - Data assurance

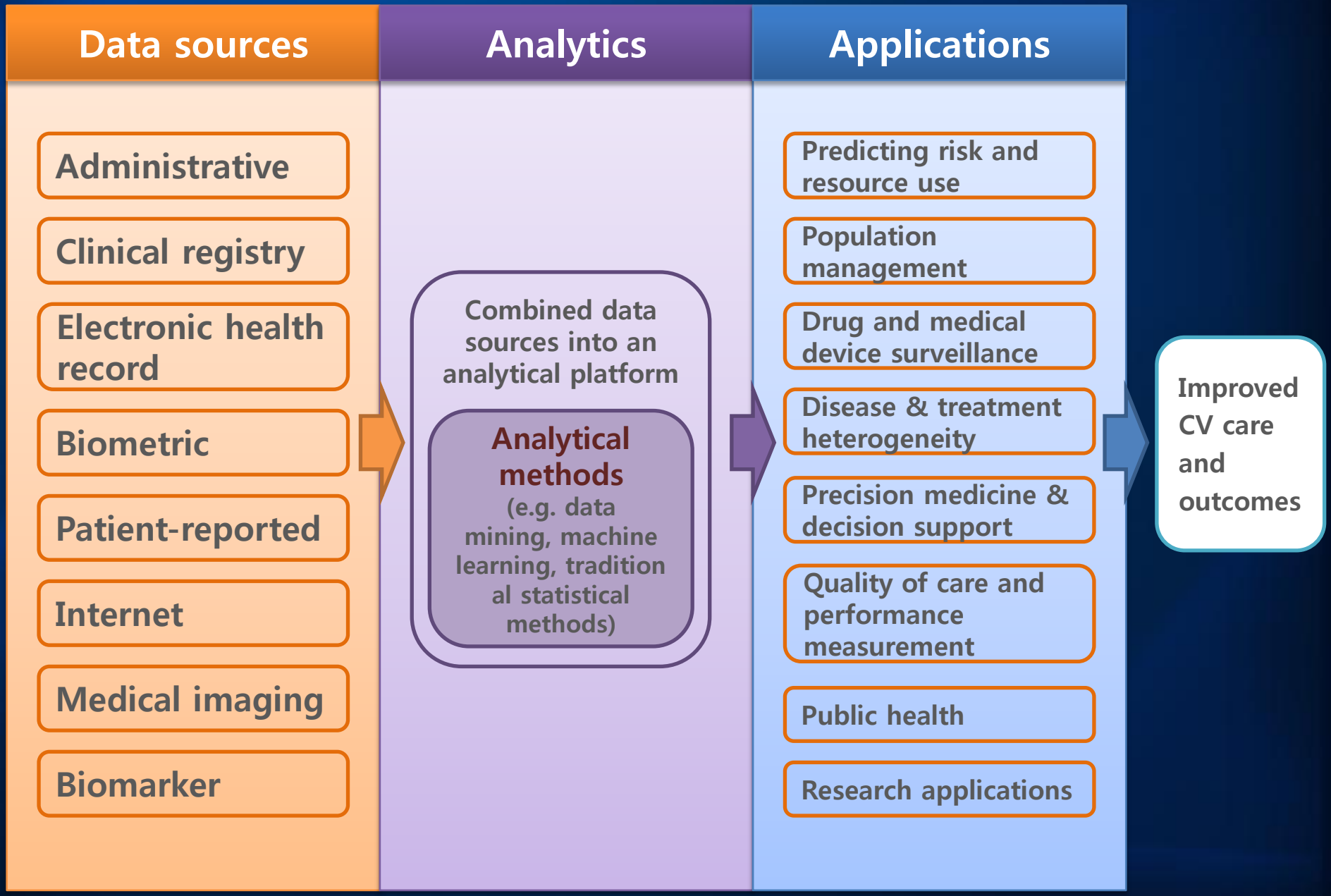
Digitalized Health Data

- SNS

- EMR
- Image
- Genetic information
- …

- Lifelog data
- Mobile device
- …

- Public data



Rumsfeld JS et al. Nat Rev Cardiol. 2016

Source of Medical Big Data

- **Human-generated data**
  - EMRs, physicians' notes, email, and paper documents
- **Biometric data**
  - Fingerprints, genetics, handwriting, retinal scans, X-rays, images, blood pressure, pulse-oximetry, etc
- **Machine-to-machine data**
  - Readings from sensors, meters, and other devices
- **Big transaction data**
  - Health care claims and other billing records
- **Web and social media data**
  - Facebook, Twitter, Linkedin, and blogs

Utilization of Medical Big Data

1. Clinical operation
2. Research & development
3. Public health
4. Evidence-based medicine
5. Genomic analytics
6. Pre-adjudication fraud analysis
7. Device / remote monitoring
8. Patient profile analytics

Raghupath W et al. Health Inform Sci Sys 2014

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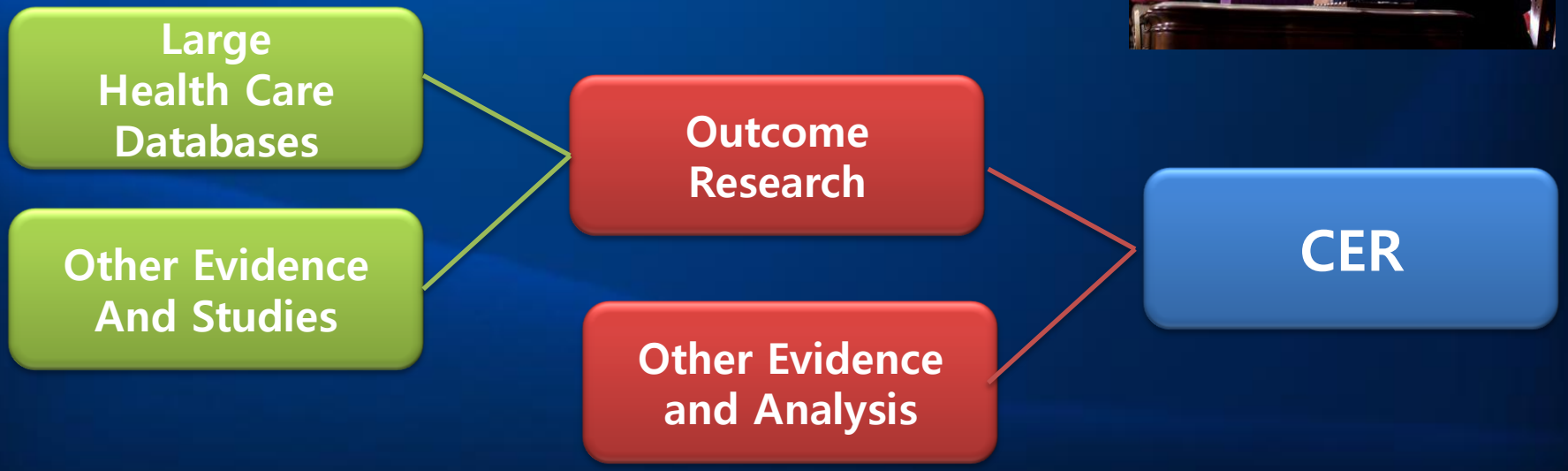
Clinical Operations

- **Comparative effectiveness research (CER)**
- **Clinical decision support system (CDSS)**

Comparative Effectiveness Research

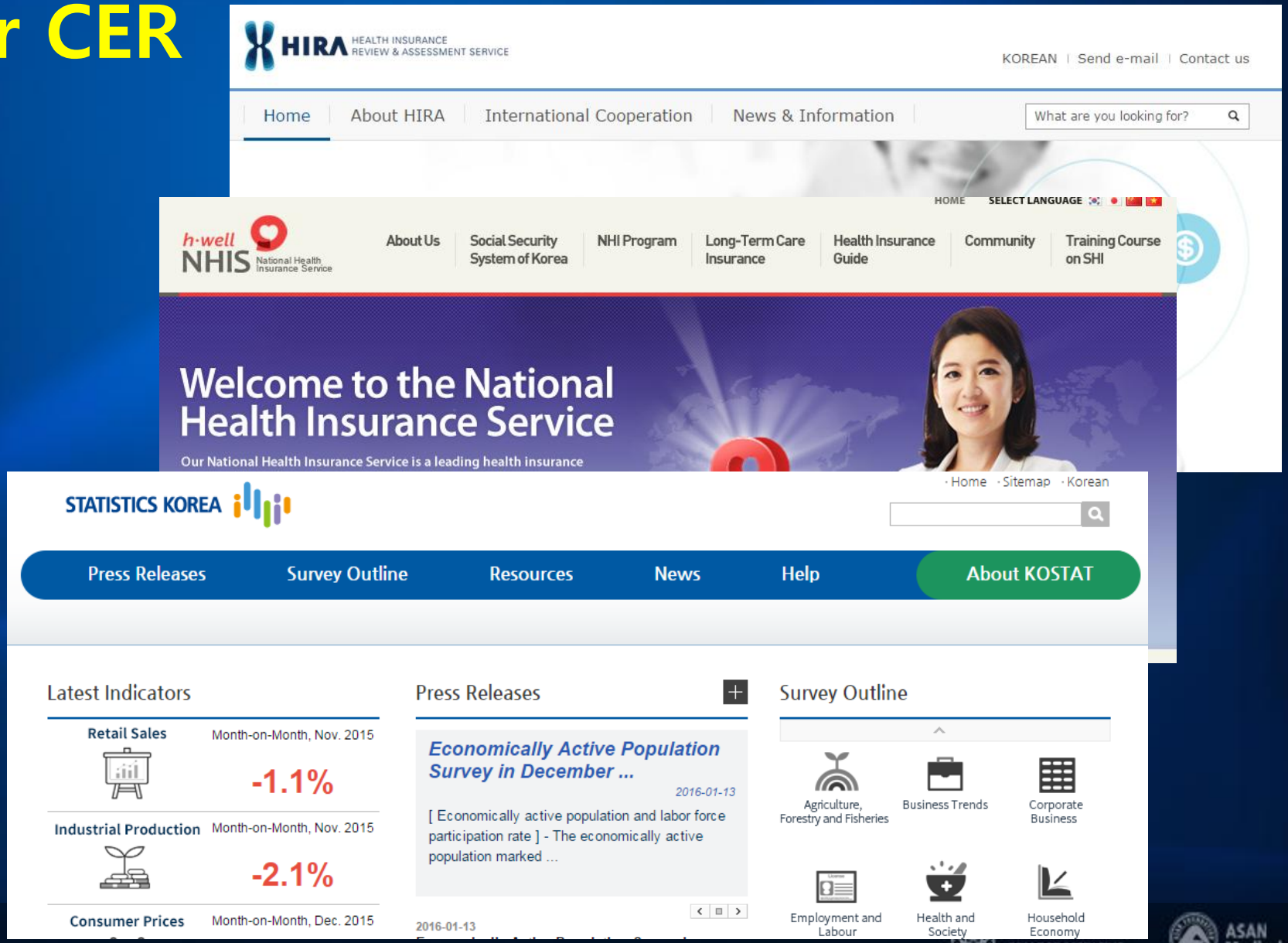
- Which treatments will work best for specific patients ("optimal treatment pathways") by analyzing comprehensive patient and outcome data to compare the effectiveness of various intervention

- > $1.1 billion for CER in USA



Disease cohort for CER

Public data for CER



□ '공공보건연구' 제안요청서(RFP)

암맹평가 대상여부	비대상
지원분야	공공보건연구
과제명	*※ 연구계획서 작성 시 과제명은 연구분야와 관련된 구체적인 연구과제명 기술*
지원규모 및 기간	연간 250백만원 이내, 31(7+12+12)개월 이내 ※ 1차년도는 연구기간이 12개월 미만이더라도, 연간 연구비 지원

▶ 사업목적

보건의료정책과 임상적 의사결정에 유용한 과학적 근거를 제공할 수 있는 공공보건연구로서 진단, 치료의 효과와 위험을 비교하여, 장기적으로 국가 보건의료재정의 건전화에 이바지할 수 있는 공익적 연구

▶ 사업목표

정부정책 추진의 아젠다 제시 및 과학적 근거 지원, 연구 결과에 근거한 고시변경, 급여변경, 특정 법령의 제·개정 등 정책 및 제도 개선에 직접적으로 활용 가능한 사항, 보건재정의 효율적 사용을 위한 근거 제시, 임상현장 진료 결정기준 변경

▶ 연구범위 및 내용

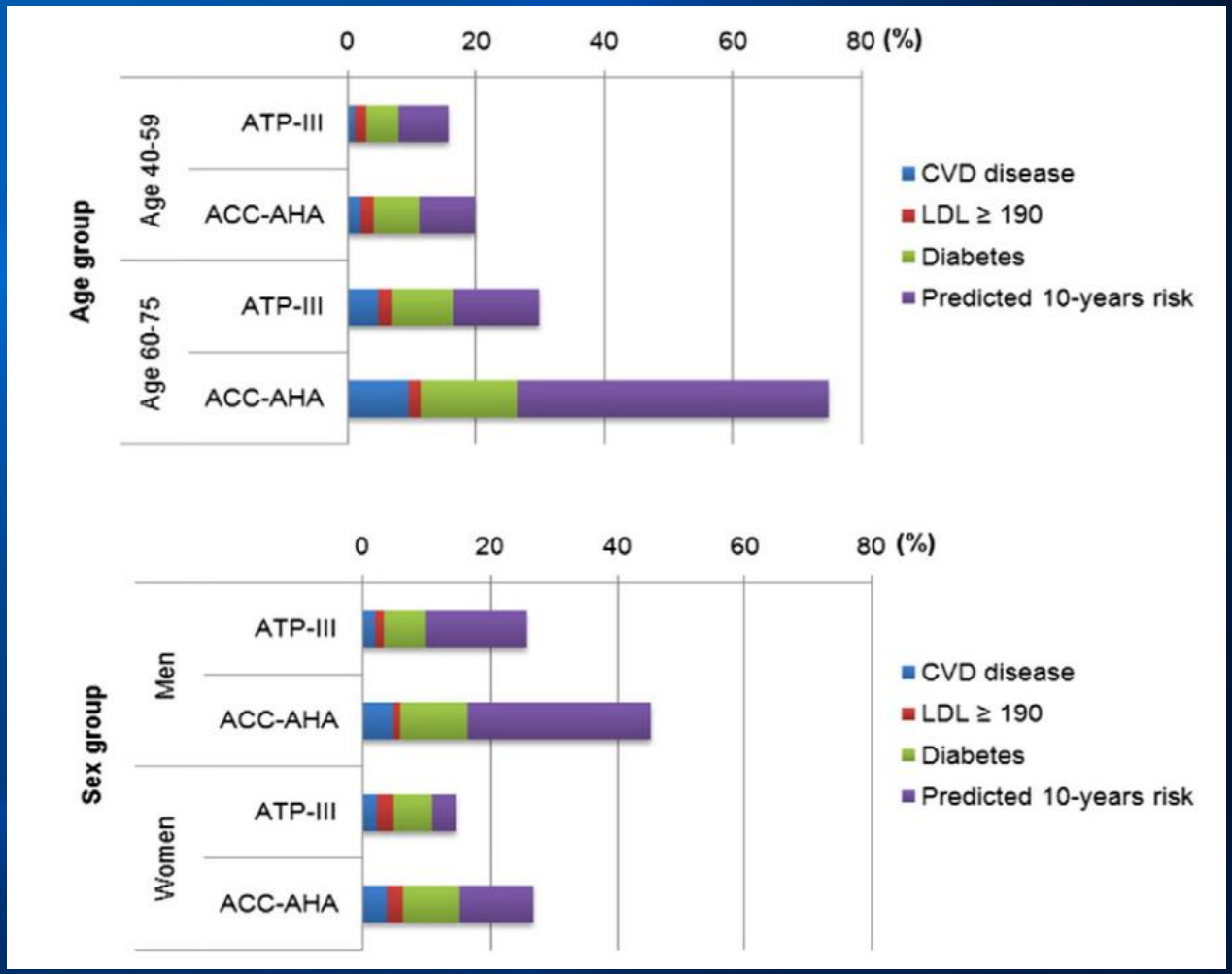
○ 전향적 임상연구 또는 근거통합 성과연구를 지원함
- (전향적 임상연구) 연구 시작부터 연구설계에 따라 환자 또는 지역 주민을 추적 관찰하거나 조사하여 자료를 획득하는 연구
- (근거통합 성과연구) 체계적 문헌고찰 및 메타분석, 의무기록 또는 이차자료원을 활용한 후향적 코호트 구축, 경제성 평가를 주요 방법으로 하는 연구

○ 인구 및 지역을 대상으로 만성질환 예방 및 건강증진을 위한 접근 전략별 성과 평가 및 비교효과 산출을 통해 보건서비스의 형평성 및 접근성 제고를 위한 근거를 제시할 수 있는 연구자의 창의적 과제를 지원함

No. of Koreans for Statin Therapy according to Guidelines

Using medical big data from

the Korean National Health and Nutrition Examination Survey of 2008 to 2012
(n = 18,573)



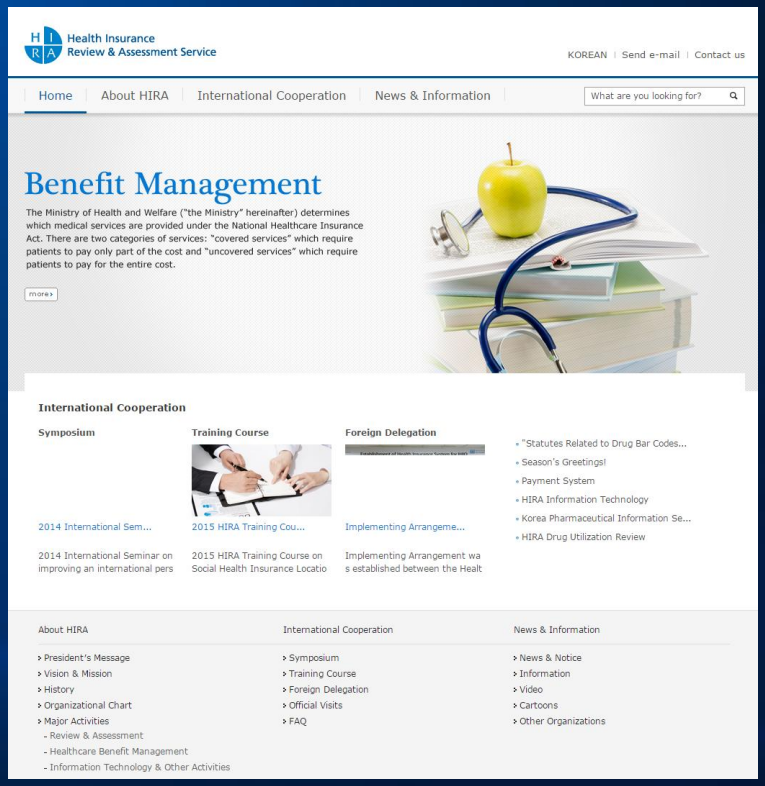
- ATP-III: Third Adult Treatment Panel guidelines
- ACC-AHA: American College of Cardiology and American Heart Association

Ko MJ et al, Am Heart J 2015;170:598

Creation of a Prediction Model with Big Data Analysis using Hospital Data Linked by Public Data

Health Data
Health Promotion Center in AMC

Public Data
Health Insurance in Korea



Park GM, Kim YH, et al. Circ Cardiovasc Qual Outcomes. 2014;7:944

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CV Risk Model in Korean Population

- A total of 57,393 consecutive asymptomatic Korean individuals aged 30 to 80 years without known CVD who voluntarily underwent a general health examination between January 2007 and June 2011

- **A CV event**

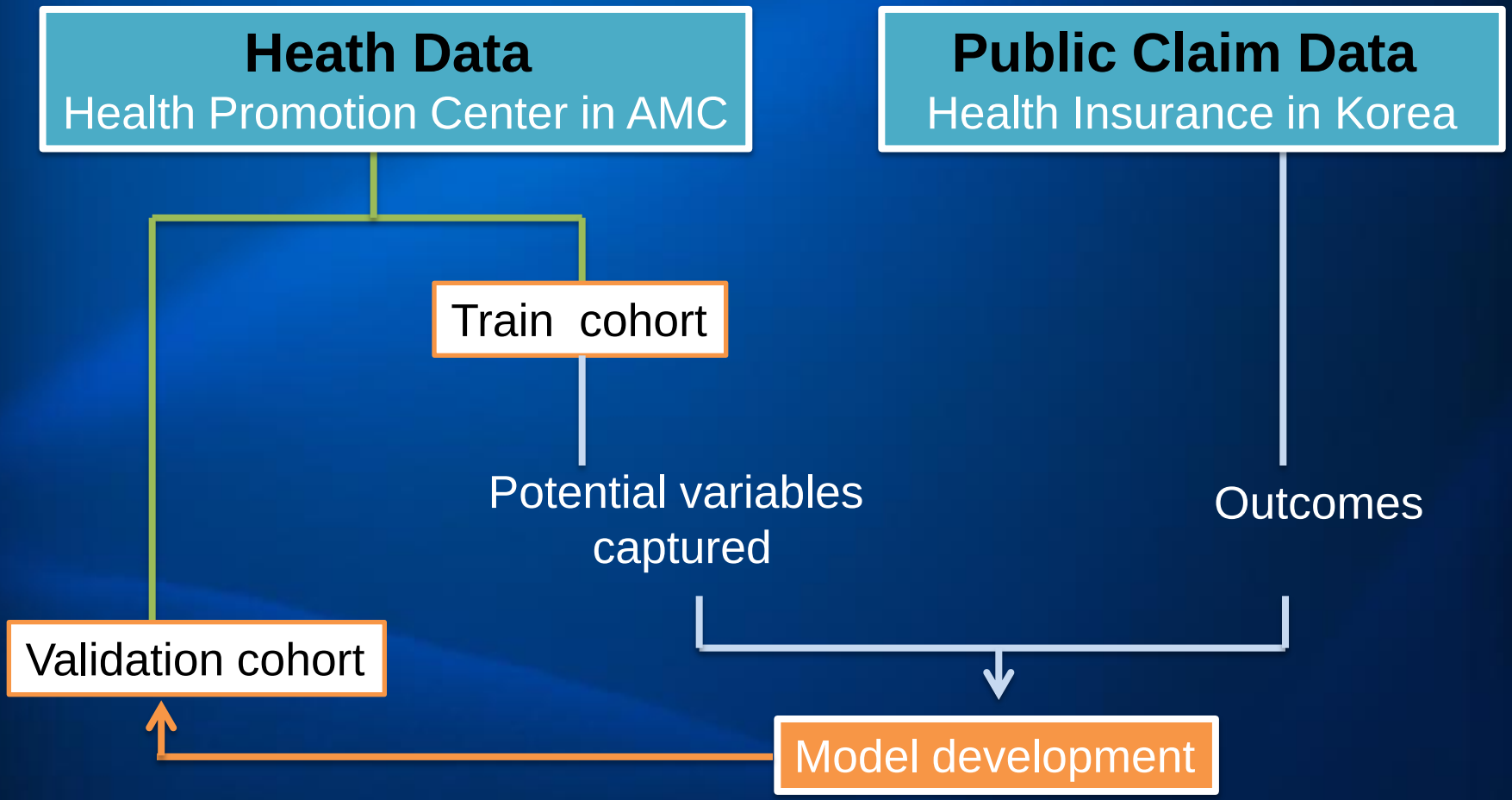
  CV death, myocardial infarction, and stroke assessed by ICD 10 codes in the claim data.

- 31 potential variables:

  age, gender, BMI, systolic/diastolic BP, waist circumference, HTN, DM, hyperlipidemia, family Hx of CHD/stroke, smoking, exercise, education, WBC, Hb, FBS, HbA1C, uric acid, BUN/Cr, cholesterol profile, ESR, CRP, AF, medication Hx of aspirin/statin

Park GM, Kim YH, et al. Circ Cardiovasc Qual Outcomes. 2014;7:944

Model Development and Validation



Park GM, Kim YH, et al. Circ Cardiovasc Qual Outcomes. 2014;7:944

Study Population

91,636 individuals aged 30 to 80 years who underwent health examination in the health promotion center at the Asan Medical Center from January 2007 to June 2011

25,897 Refused participation
8,346 Excluded
- **4,574 Previous CVD history in HIRA data**
- **1,310 Not available in HIRA data**
- **1,822 Previous history of angina or MI**
- **344 Previous history of stroke**
- **183 Structural heart disease**
- **56 Previous history of PCI**
- **37 Previous history of heart procedure**
- **20 Previous history of open heart surgery**

57,393 subjects enrolled

45,914 in the Train cohort

11,479 in the Validation cohort

Park GM, Kim YH, et al. Circ Cardiovasc Qual Outcomes. 2014;7:944

Modeling

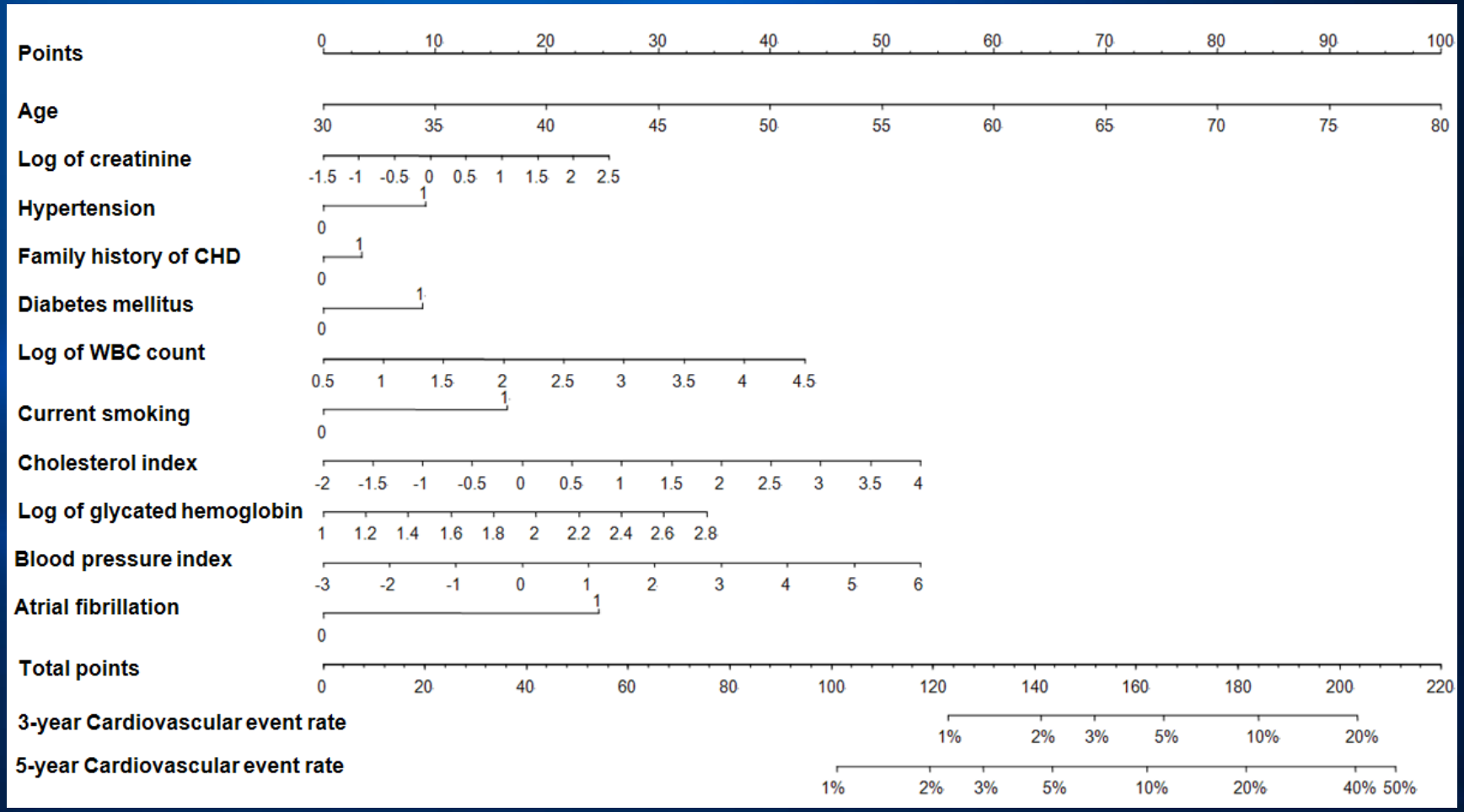
13 possible scenario models in the train cohort

Table Ⅱ. Performance of the Possible Scenario Models for Cardiova the Train Cohort.*

Models	Variables	Coefficient	H
1	Framingham risk model for 10-year CHD	11.877	
	C-index (95% confidence interval)		0.7
	Akaike Information Criterion		
	Shrinkage		
2	Framingham risk model for 10-year CVD	6.778	
	C-index (95% confidence interval)		0.6
	Akaike Information Criterion		
	Shrinkage		
3	Age	0.083	
	C-index (95% confidence interval)		0.6
	Akaike Information Criterion		
	Shrinkage		
4	Age	0.081	
	Log of creatinine	1.111	
	C-index (95% confidence interval)		0.7
	Akaike Information Criterion		
	Shrinkage		
5	Age	0.070	
	Log of creatinine	0.958	
	Hypertension	0.655	
	C-index (95% confidence interval)		0.7
	Akaike Information Criterion		
	Shrinkage		
6	Age	0.066	
	Log of creatinine	1.007	
	Hypertension	0.606	
	Log of erythrocyte sedimentation rate	0.215	
	Aspirin	0.279	
	C-index (95% confidence interval)		0.7
	Akaike Information Criterion		
	Shrinkage		
7	Age	0.068	
	Log of creatinine	0.923	
	Hypertension	0.602	
	Log of erythrocyte sedimentation rate	0.175	
	Log of white blood cell count	0.727	
	C-index (95% confidence interval)		0.7
	Akaike Information Criterion		
	Shrinkage		
8	New built Framingham risk model for CHD		
	Age		
	Low-density lipoprotein cholesterol		
	High-density lipoprotein cholesterol		
	Diabetes mellitus		
	Current smoking		
	Categorized blood pressure		
	Normal		
	Optimal		
	High normal		
	Grade1		
	Grade2		
	Grade3		
	Gender		
	C-index (95% confidence interval)		
	Akaike Information Criterion		
	Shrinkage		
9	Age		
	Log of creatinine		
	Hypertension		
	Log of erythrocyte sedimentation rate		
	Log of white blood cell count		
	Current smoking		
	Cholesterol index†		
	C-index (95% confidence interval)		
	Akaike Information Criterion		
	Shrinkage		
10	Age		
	Family history of CHD		
	Log of creatinine		
	Hypertension		
	Log of glycated hemoglobin		
	Current smoking		
	Atrial fibrillation		
	Blood pressure index‡		
	Cholesterol index†		
	C-index (95% confidence interval)		
	Akaike Information Criterion		
	Shrinkage		
11	Best-fitting predictive model		
	Age	0.074	1.077	<.001
	Log of creatinine	0.556	1.744	0.017
	Hypertension	0.343	1.409	0.008
	Family history of CHD	0.140	1.150	0.417
	Diabetes mellitus	0.366	1.441	0.034
	Log of white blood cell count	0.279	1.322	0.186
	Current smoking	0.686	1.986	<.001
	Cholesterol index†	0.214	1.239	0.106
	Log of glycated hemoglobin	0.501	1.650	0.291
	Blood pressure index‡	0.255	1.290	<.001
	Atrial fibrillation	0.795	2.214	0.056
	C-index (95% confidence interval)		0.757 (0.726–0.788)	
	Akaike Information Criterion		7207	
	Shrinkage		0.969	
12	Age	0.072	1.075	<.001
	Family history of CHD	0.141	1.151	0.414
	Log of creatinine	0.618	1.854	0.007
	Hypertension	0.368	1.445	0.004
	Log of erythrocyte sedimentation rate	0.162	1.175	0.043
	Log of white blood cell count	0.230	1.259	0.277
	Current smoking	0.708	2.031	<.001
	Cholesterol index†	0.146	1.158	0.269
	Log of glycated hemoglobin	1.075	2.930	0.002
	Blood pressure index‡	0.245	1.278	<.001
	Atrial fibrillation	0.799	2.223	0.055
	C-index (95% confidence interval)		0.755 (0.724–0.787)	
	Akaike Information Criterion		7207	
	Shrinkage		0.969	
13	New built Framingham risk model for CVD			
	Log of age	3.344	28.320	<.001
	Log of total cholesterol	0.560	1.750	0.061
	Log of high-density lipoprotein cholesterol	−0.587	0.556	0.009
	Log of systolic blood pressure	2.187	8.909	<.001
	Treatment of hypertension	−0.008	0.992	0.999
	Diabetes mellitus	0.458	1.581	<.001
	Current smoking	0.773	2.166	<.001
	Gender	−0.016	0.985	0.902
	Interaction between log of systolic blood pressure and treatment	0.106	1.111	0.906
	C-index (95% confidence interval)		0.751 (0.719–0.782)	
	Akaike Information Criterion		7219	
	Shrinkage		0.974	

Park GM, Kim YH, et al. Circ Cardiovasc Qual Outcomes. 2014;7:944

Prognostic Nomogram for Korean CV Risk



Park GM, Kim YH, et al. Circ Cardiovasc Qual Outcomes. 2014;7:944

Korean CV Risk Model

Automatic CV risk calculator, excel file

Please enter the blue shaded areas below.			
Age, years			
Diabetes mellitus		Yes=1 No=0	
Hypertension		Yes=1 No=0	
Current smoking		Yes=1 No=0	
Family history of coronary heart disease		Yes=1 No=0	
Systolic blood pressure, mmHg Diastolic blood pressure, mmHg		Blood pressure index	-7.5833
Atrial fibrillation on ECG		Yes=1 No=0	
White blood cell count, ×103/μL		Log of white blood cell count	#NUM!
Creatinine, mg/dL		Log of creatinine	#NUM!
Glycated hemoglobin, %		Log of glycated hemoglobin	#NUM!
Total cholesterol, mg/dL Low-density lipoprotein cholesterol, mg/dL High-density lipoprotein cholesterol, mg/dL		Cholesterol index	-0.6720
3-year event rate (%)			
Cardiovascular death/MI/Stroke		#NUM!	

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A case

Korean Model
5 year risk of CV event
9.5%

Please enter the blue shaded areas below.			
Age, years	66		
Diabetes mellitus	0	Yes=1 No=0	
Hypertension	1	Yes=1 No=0	
Current smoking	0	Yes=1 No=0	
Family history of coronary heart disease	0	Yes=1 No=0	
Systolic blood pressure, mmHg Diastolic blood pressure, mmHg	150 90	Blood pressure index	1.9167
Atrial fibrillation on ECG	0	Yes=1 No=0	
White blood cell count, ×10³/μL	7	Log of white blood cell count	1.9459
Creatinine, mg/dL	0.6	Log of creatinine	-0.5108
Glycated hemoglobin, %	6	Log of glycated hemoglobin	1.7918
Total cholesterol, mg/dL Low-density lipoprotein cholesterol, mg/dL High-density lipoprotein cholesterol, mg/dL	200 130 40	Cholesterol index	0.3782
5-year event rate (%)			
Cardiovascular death/MI/Stroke		9.4900	

ACC/AHA Model
10 year risk of CV event
23.0%

Park GM, Kim YH, et al. Circ Cardiovasc Qual Outcomes. 2014;7:944

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An example of Comparative Effective Research (CER)

- **To compare the clinical implications of anatomic versus functional evaluation as the initial test for stable CAD.**

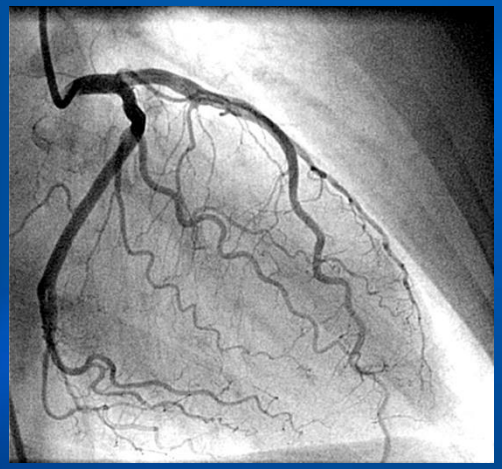
- This study was conducted with the permission of the National Strategic Coordinating Center of Clinical Research and the Health Insurance Review & Assessment Service (HIRA) in Korea.

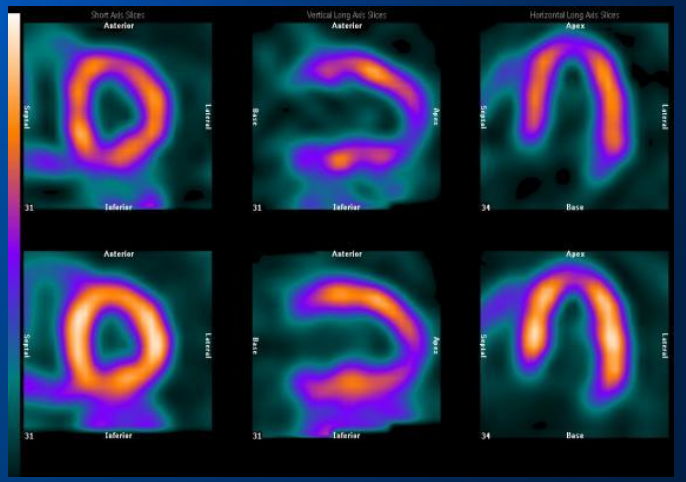
- In this present study, data from 2009–2013 claims records of the HIRA were used.

- Diagnosis codes were used in the International Classification of Diseases, 10th Revision (ICD-10). Procedures are identified by codes from the HIRA database.

Park GM, Kim YH, et al. J Nucl Med 2016 (in print)

Invasive Coronary Angiography (CAG) vs. Myocardial Perfusion Imaging (MPI)

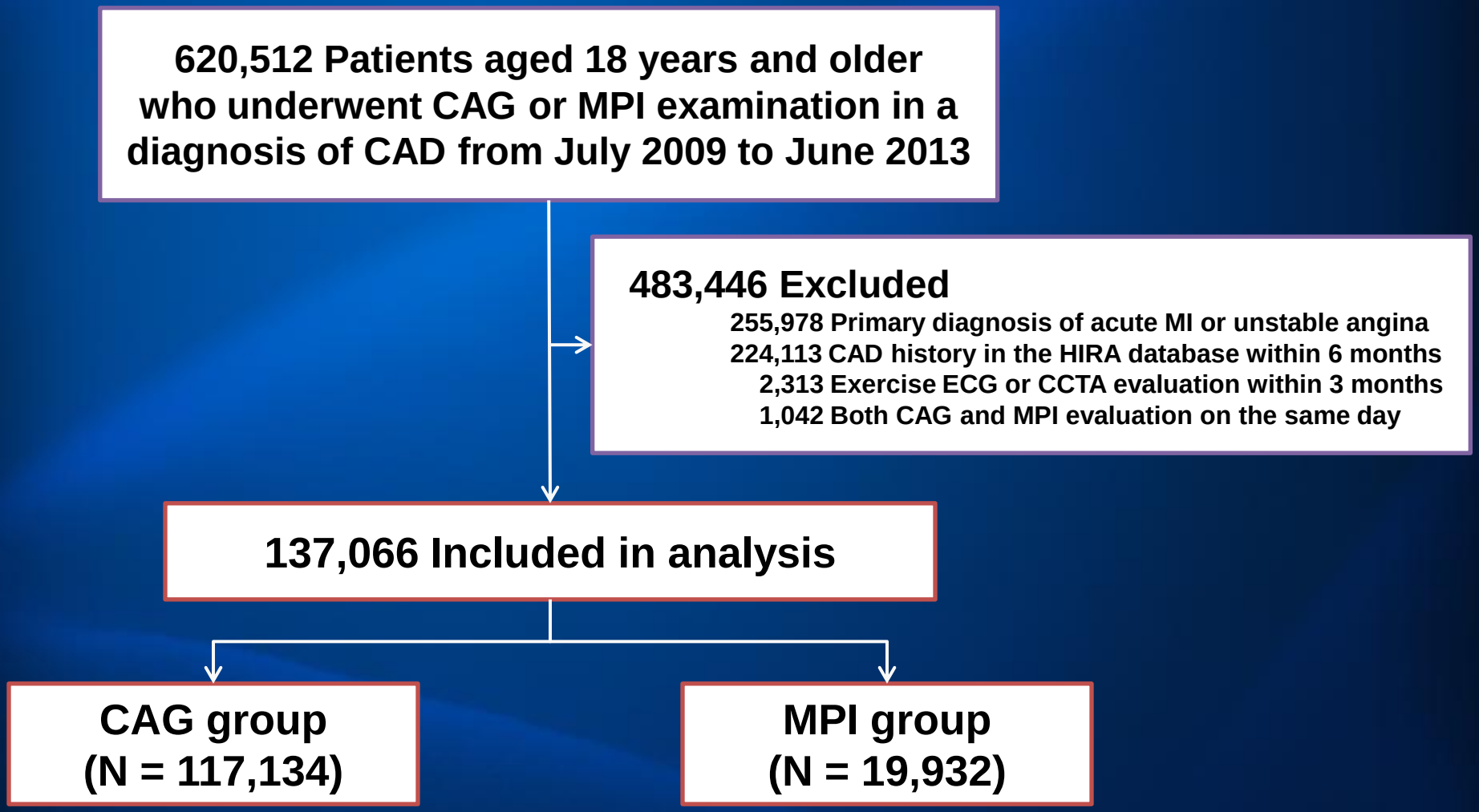




- Radiation, contrast hazard
- High cost
- Procedural complication
- Good lesion localization
- Good for subsequent revascularization
- Not recommended for stable angina as the initial assessment

- No contrast hazard
- Relatively low cost
- No procedural complication
- Poor lesion localization
- Recommended for stable angina as the initial assessment

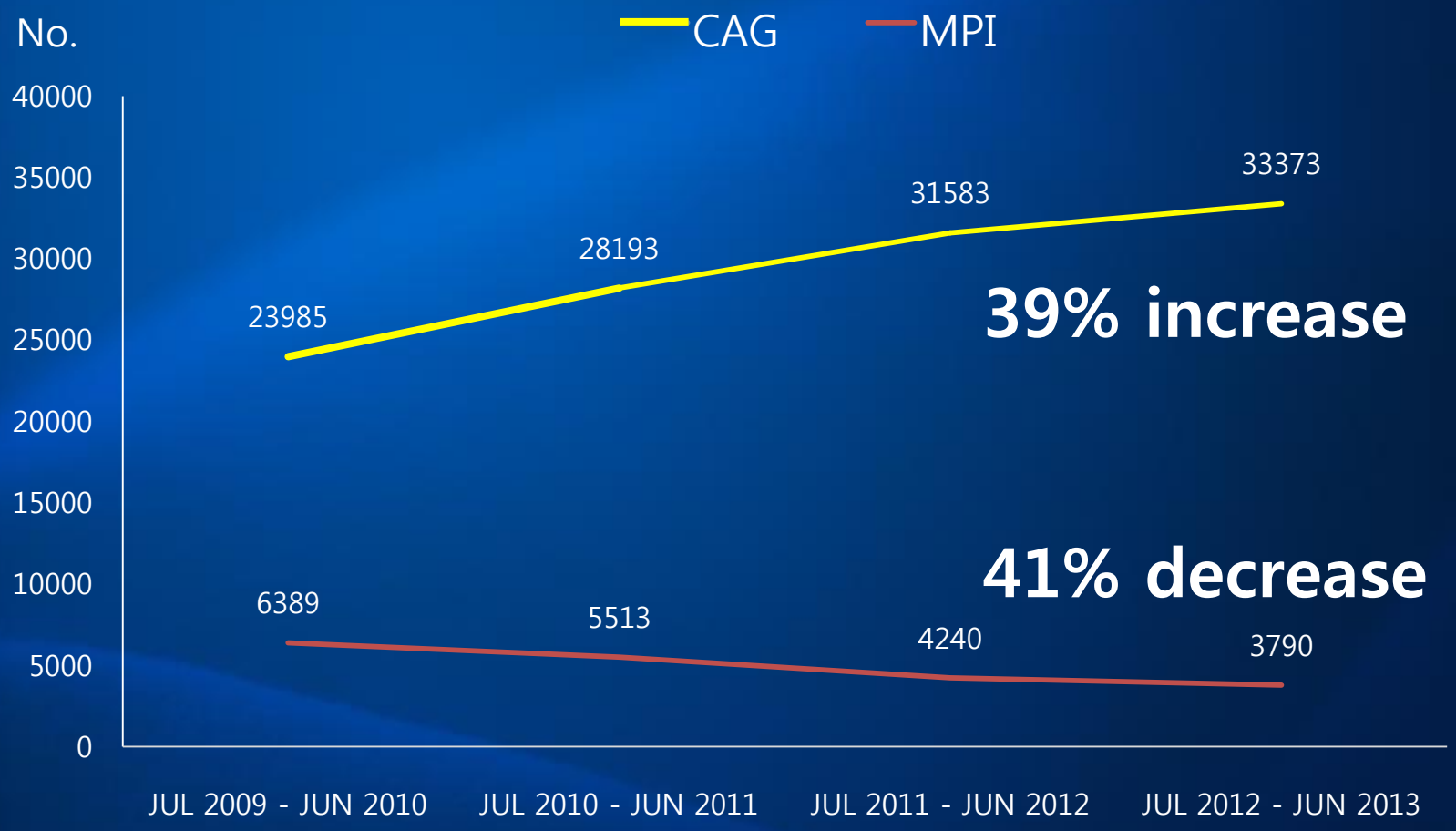
Patients from the HIRA Public DB



CAG = invasive coronary angiography, MPI = myocardial perfusion imaging

Park GM, Kim YH, et al. J Nucl Med 2016 (in print)

National Trends in the use of CAG vs. MPI



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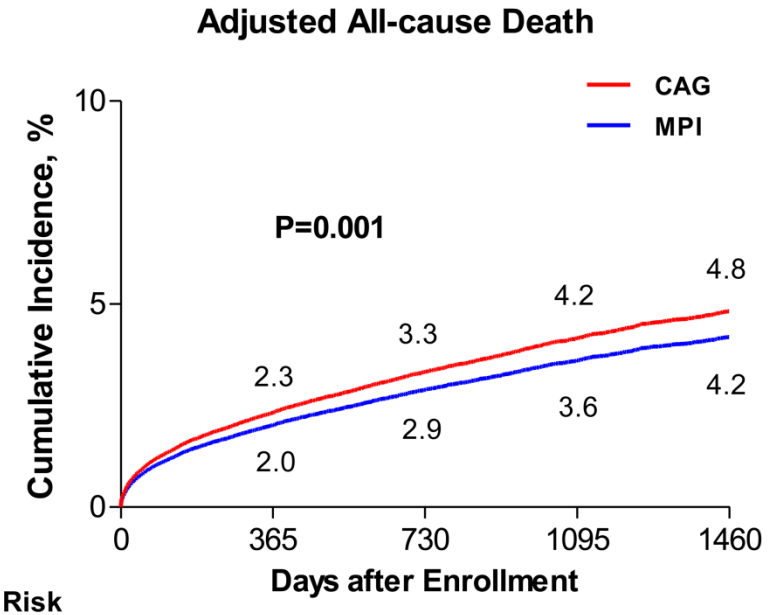
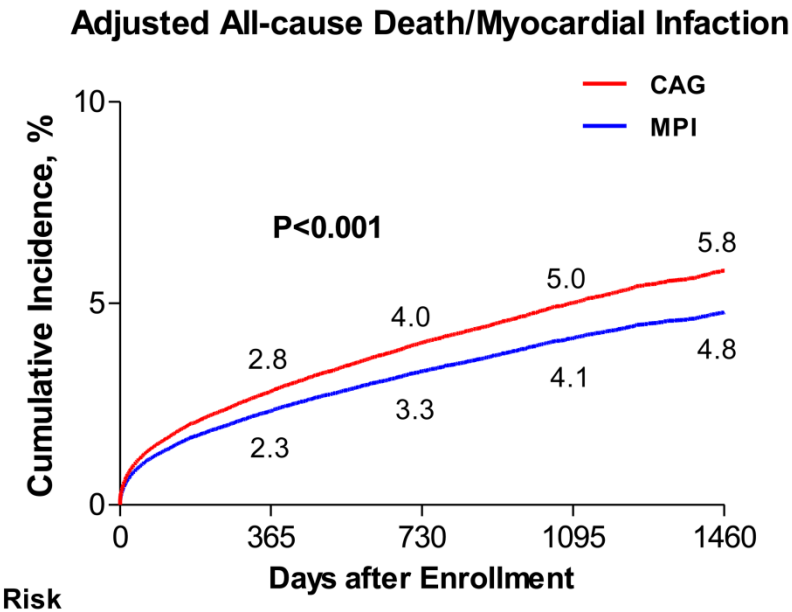
Adjusted Outcomes



No. at Risk

CAG	117134	101077	70294	41323	14383
MPI	19932	17765	12193	7258	2734



No. at Risk

CAG	117134	100434	69655	40823	14174
MPI	19932	17718	12143	7485	2715

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Adjusted Hazard Ratio

Adjusted clinical outcomes with IPTW	Incidence rate [a]		CAG compared with MPI	
	MPI (95% CI)	CAG (95% CI)	Adjusted Hazard ratio (95% CI)	p
All-cause death	13.43 (12.41–14.45)	16.08 (15.32–16.83)	**1.19** (1.09–1.29)	<0.001
Myocardial infarction (MI)	2.27 (1.84–2.69)	4.15 (3.80–4.51)	**1.81** (1.49–2.20)	<0.001
Coronary revascularization	2.19 (1.68–2.70)	63.03 (61.64–64.41)	**26.27** (21.86–31.58)	<0.001
All-cause death / MI	15.33 (14.23–16.43)	19.53 (18.70–20.35)	**1.26** (1.16–1.36)	<0.001

- Unnecessary coronary angiography may not be uncommon in Korea
- Noninvasive functional evaluation need to be performed as the initial assessment of CAD

Park GM, Kim YH, et al. J Nucl Med 2016 (in print)


심혈관 질환 예방 및 관리방안 마련을 위한 업무협약(MOU) 체결
2016. 2. 23.
대한심장학회
국민건강보험공단 이사장
성 상 철
대한심장학회 이사장
오 병 희

Clinical Decision Support System (CDSS)
의사결정지원

- Provides clinicians, staff, patients, and other individuals with knowledge and person-specific information, intelligently filtered and presented at appropriate times, to enhance health and health care

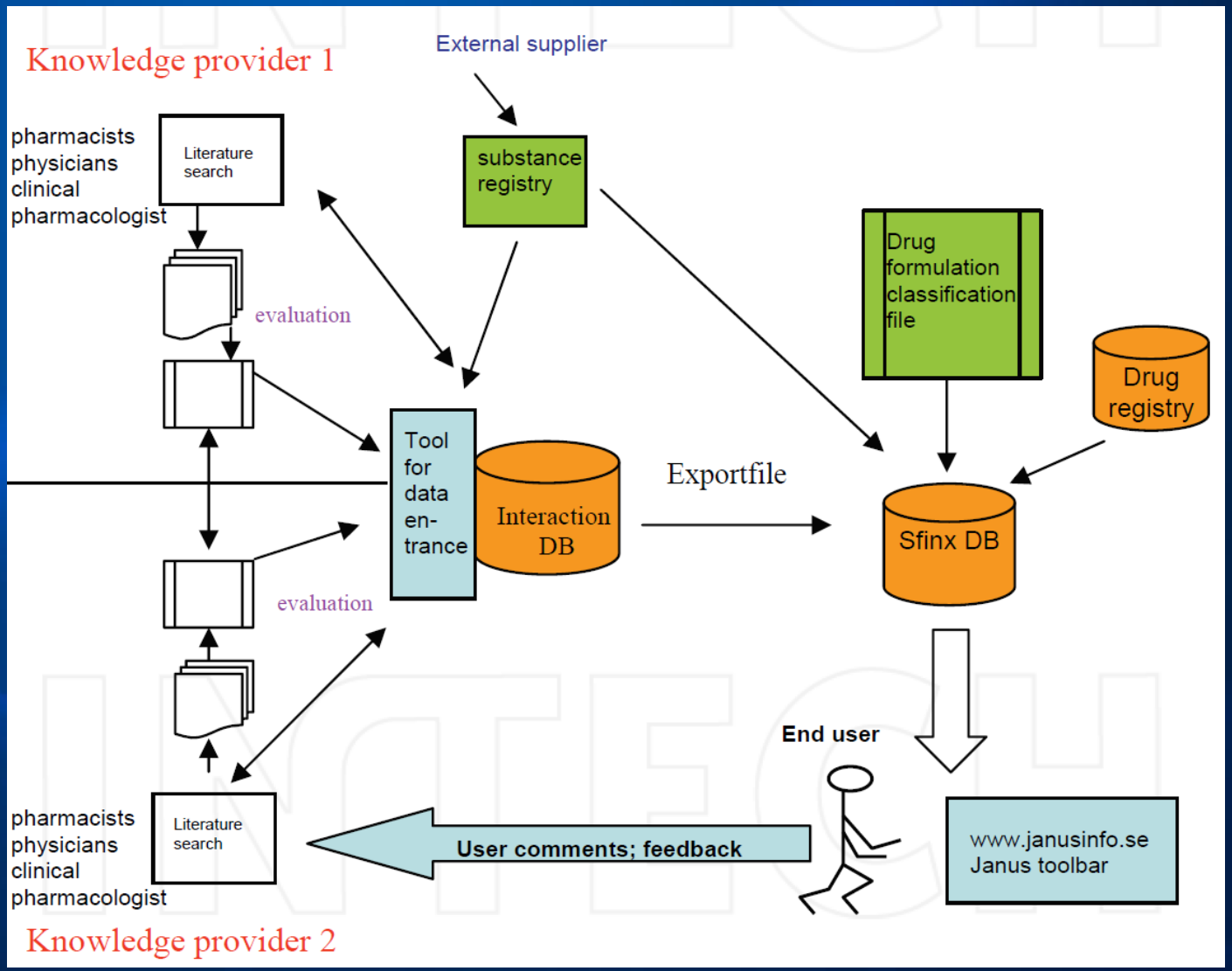
- Links health observations with medical knowledge in order to assist clinicians in decision making

Why CDSS?
Common Medical Errors

1. Filing system errors
2. Prescribing erroneous medications
3. Dispensing the wrong medications
4. Inappropriately ordering laboratory tests for the wrong patient at the wrong time
5. Failing to promptly respond to abnormal laboratory test results

Jao CS, Hier DB. IntechOpen 2013

Knowledge-Based CDSS



Birgit Eiermann et al. Intechopen 2013

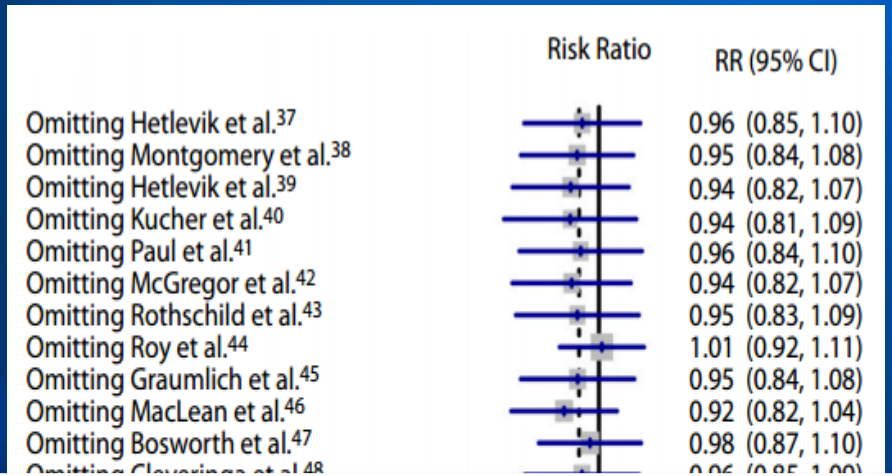
Potential Role of CDSS

Target Area of Care	Example
Preventive care	Immunization, screening, disease management guidelines for secondary prevention
Diagnosis	Suggestions for possible diagnoses that match a patient's signs and symptoms
Planning or implementing treatment	Treatment guidelines for specific diagnoses, drug dosage recommendations, alerts for drug-drug interactions
Follow-up management	Corollary orders, reminders for drug adverse event monitoring
Hospital, provider efficiency	Care plans to minimize length of stay, order sets
Cost reductions and improved patient convenience	Duplicate testing alerts, drug formulary guidelines

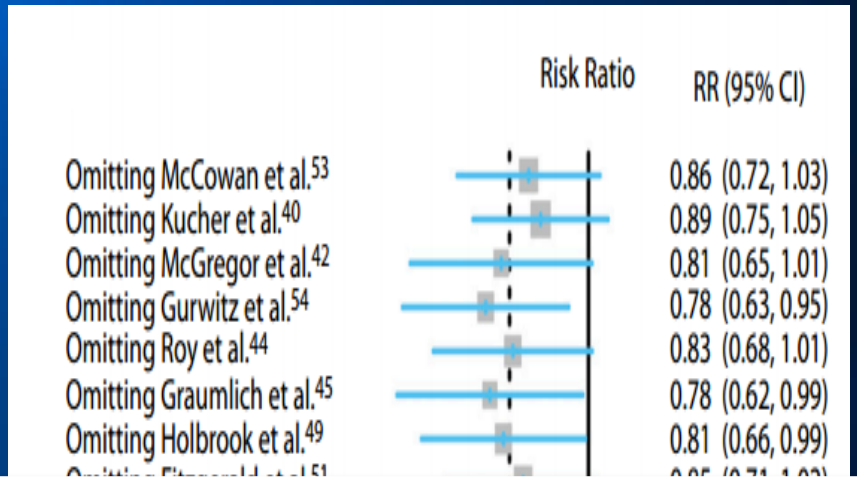
Eta S. Berner, Ed.D. Agency for Healthcare Research and Quality 2009

Meta-analysis of CDSS

Mortality



Morbidity



- **Marginal benefit of knowledge-based CDSS** in this meta-analysis
- The next generation of CDSS trials should focus on systems with a more global outlook featuring authoritative point-of care services and **full integration with EHRs**.
- The benefit of cardiovascular CDSS should be evaluated for healthcare providers of cardiology specialists and non-specialists.

Moja L et al. Am J Public Health.2014;104:e12

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The Oncology Expert Advisor

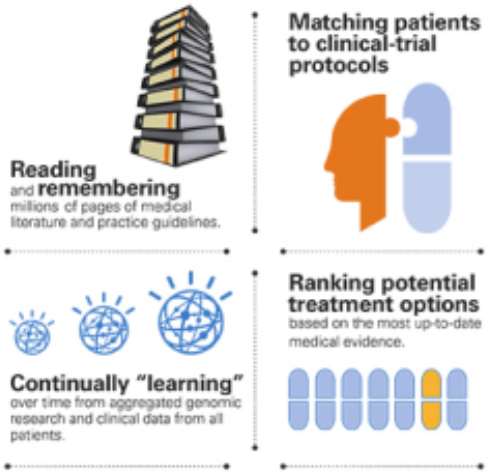
Annual Report - Annual Report - Winter 2014

There were 14.1 million new cancer cases worldwide in 2012.

seminal discoveries, seismic changes

Most cancer patients can't travel to MD Anderson for the expert care that comes from more than 70 years of institutional expertise fighting the disease. In the short term, the fastest way to improve patient outcomes on a global level is to elevate and standardize cancer care in communities served by MD Anderson's network of partners throughout the U.S. and around the world.

The Oncology Expert Advisor is capable of:



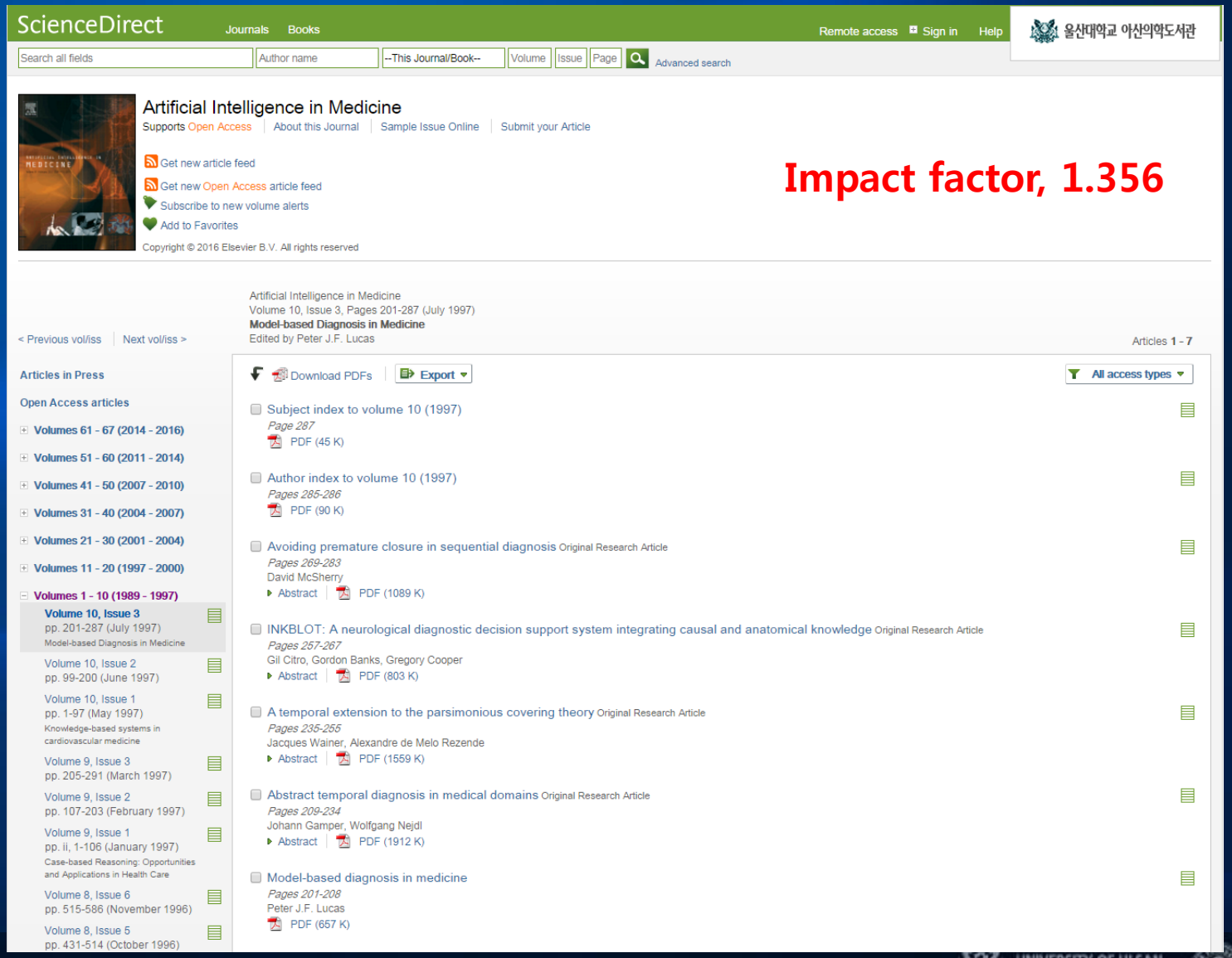
Annual Report - Winter 2014

Annual Report Home
From our president
Track the journey, lower the risk
Seminal discoveries, seismic changes
Treat the immune system, attack the cancer
Enhance patient experience, build networks

People and data
Faculty
Board of visitors
Donors
Financial and statistical data

PDFs
Page-turning PDF
Standard PDF

Artificial Intelligence



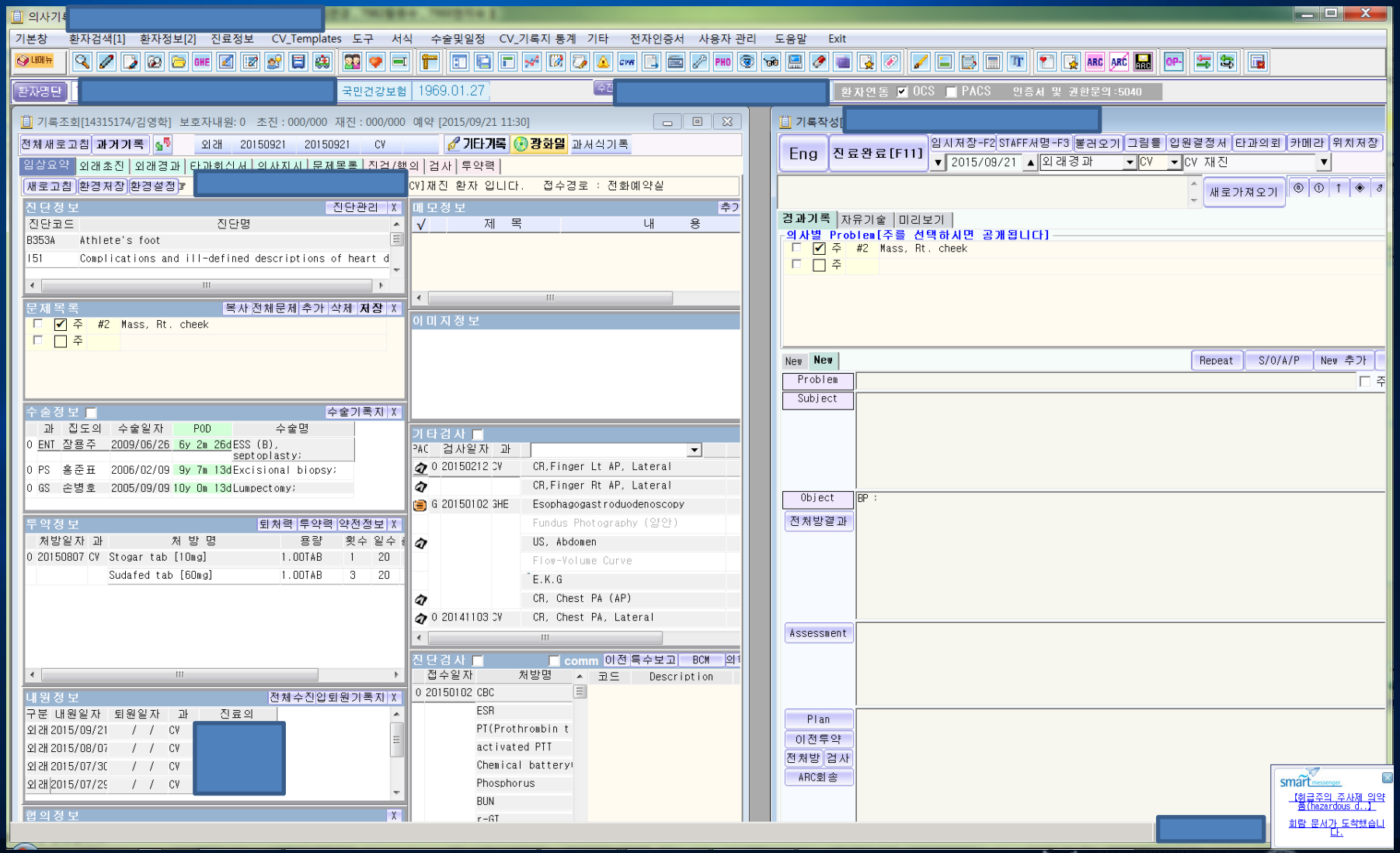
Hospital Data

Editorial

Natural Language Processing and the Promise of Big Data

Small Step Forward, but Many Miles to Go

Thomas M. Maddox, MD, MSc; Michael A. Matheny, MD, MS, MPH



Characteristics of EMR Data

- **Structured data** can be abstracted, stored, and analyzed relatively easily with current technology.

- **Unstructured data**, which contain vitally important information such as subtle nuances about a patient's condition, a provider's clinical reasoning, and a patient's preferences for treatments, remain largely inaccessible.

Characteristics of EMR Data

Structured data

검사코드	검사명	검사결과값	비교	하한	상한	단위
L20	일반혈액검사	20150102:094651				
L2011	WBC	5.2		4	10	x10³/uL
L2012	RBC	4.51		4.2	6.3	x10^6/uL
L2013	Hb	15.9		13	17	g/dl
L2014	Hct	45.8		39	52	%
L2081	MCV	101.6	▲	80	100	fl
L2082	MCH	35.3	▲	27	33	pg
L2083	MCHC	34.7		32	36	%
L2021	RDW	12.3		11.5	14.5	%
L2015	Platelet	216		150	350	x10³/uL
L2085	MPV	11.2		9.1	12.1	fl
L2022	PDW	12.2		9.4	15.0	fl
L2016	ESR	7		0	9	mm/hr
L20191	E-Neutrophil	39.1	▼	50	75	%
L20191	E-Lymphocyte	51.4	▲	20	44	%
L20191	E-Monocyte	5.9		2	9	%
L20191	E-Eosinophil	3.4		1	7	%
L20192	E-Basophil	0.2		0	2	%
L2055	IG %	0.2				%
L20300	E-ANC	2030				/uL

Unstructured data

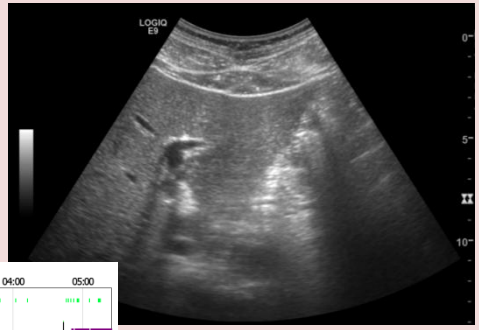
US, Abdomen

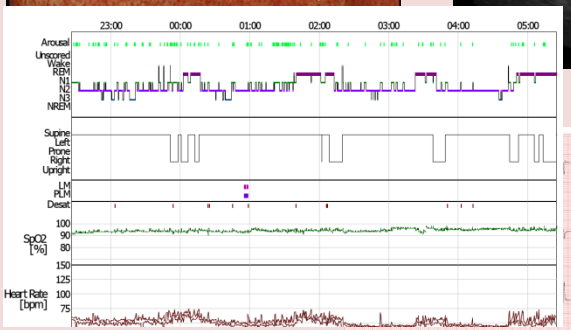
담낭 벽에 용종이 의심됨.
간, 췌장, 비장, 양측 신장에 특이소견 없음.

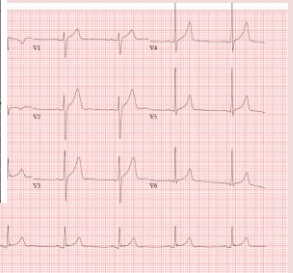
CONCLUSION:

담낭용종들, 최대 0.5 cm

<기타코드> B213







A Case of Cardiac SPECT Report on EMR

Thallium SPECT 20090210 20100202 08:06

[핵종 및 방법]

. 핵 종 : Tl-201 3.0 mCi

. 카메라 : Ventri, Ventri 1

. 방 법 : Adenosine(140㎍/kg/min)을 이용한 pharmacological stress test를 시행하였음.

※ 심장관류 SPECT시의 임상소견 ※
. 임상진단 : Angina
. 검사목적 : CAD 임상소견
. 병력 : Chest pain
. Angina : Typical
. EKG : Normal

[판 독]

. 심근섭취상태

- Stress image : Myocardial uptake of left ventricle is evenly distributed without any regional perfusion defects.

- Rest image : There is no significant change in regional distribution of tracer between stress and rest images.

. Bull's eye washout image : Circumferential profiles show normal washout patterns.

. SSS 0 , SRS 0 , SDS 0

. Gating finding
EDV : 57 ㎖ ESV : 19 ㎖ LVEF : 66%
RWM & RWT : Normal wall motion and wall thickness
SMS 3 , STS 0

[결 론]

1) Normal gated myocardial perfusion Tl-201 SPECT after adenosine stress
2) Normal LV function

Data Extraction

Rule-based pattern analysis

Unstructured data

Thallium SPECT
20110316 20110317 10:45*[핵종 및 방법] . 핵 종 : Tl-201 3.5 mCi . 카메라 : Ventri, Ventri 1 . 방 법 : Adenosine(140μg/kg/min)을 이용한 pharmacological stress test를 시행하였음. ※ 심장관류 SPECT시의 임상소견 ※ . 임상진단 : R/O Rt APN . 검사목적 : CAD 임상소견 . 병력 : Abnormal EchoCG(RCA territory ischemic insult) . Risk factors : Diabetes, 고혈압(> 140/80) or 고혈압약 복용 [판 독] . 심근 섭취상태 - Stress image : inferior wall wall 에 moderate perfusion decrease가 있음. Rest image : Normal. . Bull's eye washout image : Abnormal washout. . **SSS 12 , SRS 0 , SDS 12** . Gating finding **EDV : 67 ml ESV : 28 ml LVEF : 57% RWM & RWT : Normal** wall motion and wall thickness **SMS 1 , STS 2**

Abnormal gated myocardial perfusion Tl-201 SPECT after adenosine stress showing1) **Reversible medium** sized **moderately** decreased perfusion in **apical-mid anterior** wall2) **Reversible large** sized **mildly** decreased perfusion in apical lateral and **mid-basal anterolateral** and **mid inferolateral** wall3) **Reversible large** sized **mildly** decreased perfusion in inferior wall4) **Fixed samll** sized **moderately** decreased perfusion in **basal inferolateral** wall

Pattern recognition

Pattern definition

Reversible	reversible
Irreversable	irreversable
Fixed	fixed
Small	small
Medium	medium
Large	large
Mild	mild
Moderate	moderate
Severe	severe

Structured data

EDV	ESV	LVEF	SMS	STS
67	21	69	0	0
67	28	57	1	2
94	43	54	2	4
85	23	72	0	0
63	16	74	3	2
53	17	68	18	9
58	17	70	0	0
101	75	26	50	35
65	24	62	7	2
53	18	67	5	0
207	159	24	46	36

Reversibility	Amount	Degree	Segment
Reversible	Large	Moderate	Inferior
Reversible	Large	Moderate	Inferior
Reversible	Medium	Mild	Mid Anterolateral
Reversible	Large	Mild	Anteroseptal
Reversible	Small	Moderate	Basal Inferolateral
Fixed	Large	Mild	Apical Lateral

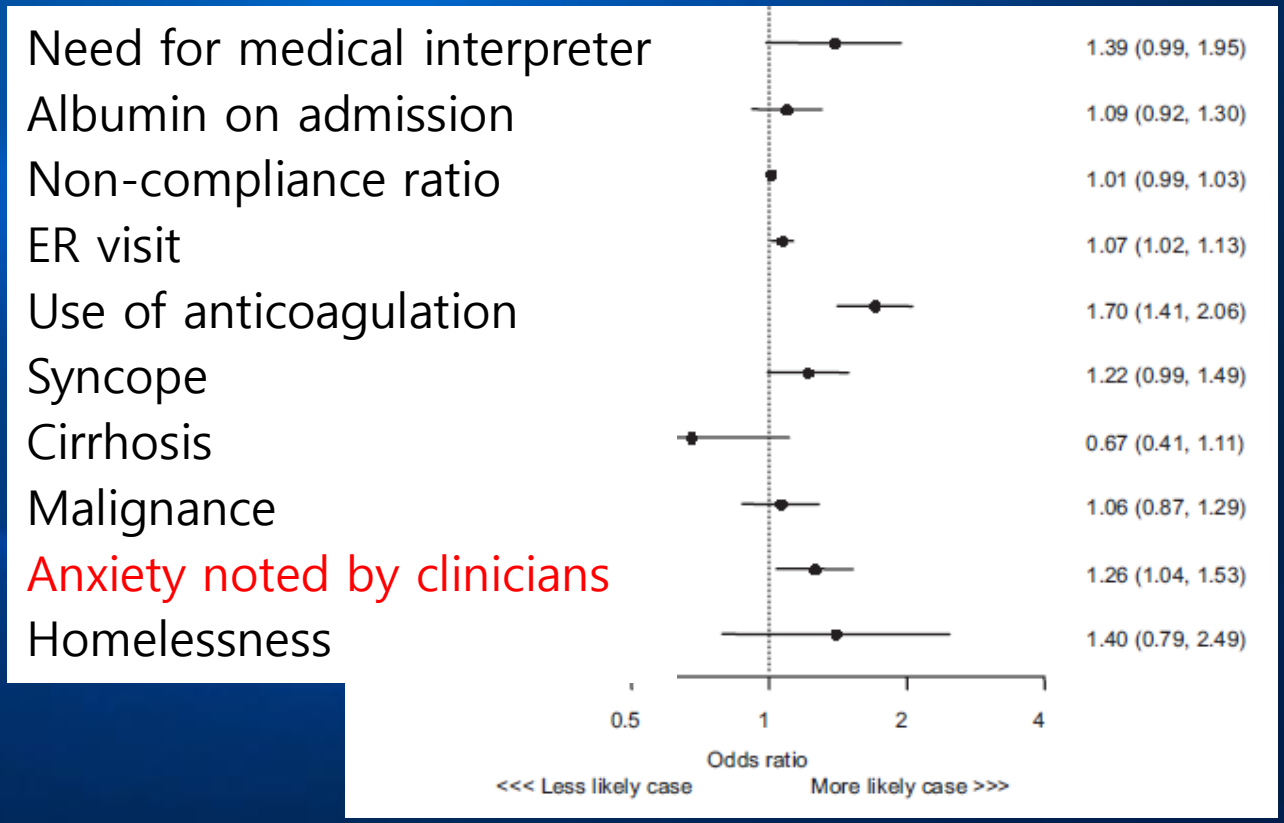
Extracted Data

❑ 전체 데이터

id	acceptYmd	성별	검사시나이	검사코드	검사코드명	결론	결과본문	결과본문순서	SSS	SRS	SDS	SMS	STS	EDV	ESV	LVEF	SMS	STS
1	20140523	F	81	N1085	Thallium S	1) Normal gated myoc	Thallium S	1	2	0	2			67	21	69	0	0
2	20110317	M	76	N1085	Thallium S	Abnormal gated myoc	Thallium S	1	12	0	12			67	28	57	1	2
2	20130724	M	79	N1085	Thallium S	Abnormal gated myoc	Thallium S	1	8	4	7			94	43	54	2	4
4	20110120	F	77	N1085	Thallium S	Abnormal gated myoc	Thallium S	1	1	2	1			85	23	72	0	0
7	20121008	F	55	N1085	Thallium S	1) Normal gated myoc	Thallium S	1	5	1	4			63	16	74	3	2
8	20111027	M	73	N1085	Thallium S	Abnormal gated myoc	Thallium S	1	3	0	3			53	17	68	18	9
9	20120903	M	61	N1085	Thallium S	Abnormal gated myoc	Thallium S	1	5	1	4			58	17	70	0	0
14	20120406	F	85	N1085	Thallium S	Abnormal gated myoc	Thallium S	1	7	12	1			101	75	26	50	35
17	20151120	M	74	N1085	Thallium S	1) Normal gated myoc	Thallium S	1	1	0	1			65	24	62	7	2
22	20151130	M	77	N1085	Thallium S	1) Normal gated myoc	Thallium S	1	1	2	1			53	18	67	5	0
24	20111012	M	66	N1085	Thallium S	Abnormal gated myoc	Thallium S	1	5	8	4			207	159	24	46	36
27	20111121	F	79	N1085	Thallium S	Abnormal gated myoc	Thallium S	1	1	0	1			64	24	63	1	0
28	20120413	F	68	N1085	Thallium S	1) Normal gated myoc	Thallium S	1	2	1	2			62	24	61	1	0
28	20130927	F	69	N1085	Thallium S	1) Normal gated myoc	Thallium S	1	0	0	0			53	22	59	6	0
28	20150519	F	71	N1085	Thallium S	1) Normal gated myoc	Thallium S	1	0	1	0			61	25	59	9	0
34	20111005	F	74	N1085	Thallium S	1) Normal gated myoc	Thallium S	1	0	0	0			82	13	84	0	0
39	20111111	F	67	N1085	Thallium S	1) Normal gated myoc	Thallium S	1	1	1	1			112	47	58	0	0
40	20120406	F	72	N1085	Thallium S	1) Normal gated myoc	Thallium S	1	5	1	4			50	9	81	0	0
41	20110112	F	68	N1085	Thallium S	1) Normal gated myoc	Thallium S	1	1	0	1			43	15	66	3	0
42	20111104	M	74	N1085	Thallium S	1) Normal gated myoc	Thallium S	1	12	6	8			94	40	58	2	1
42	20140627	M	77	N1085	Thallium S	1) Normal gated myoc	Thallium S	1	1	1	1			71	32	55	3	4

요구사항 명세서 | DB 테이블 명세서 | Thallium M | Thallium M 패턴상세 | 데이터 추출과정 | 추출 결과 전체 데이터

Natural language processing (NLP)
Predictive Factors of 3-day Readmission after Coronary Stenting
in Massachusetts General Hospital (MGH)



Wasfy JH et al. Circ Cardiovasc Qual Outcomes 2015;8

Supervised Machine Learning
with EHR to predict heart-related hospitalization
in Boston Medical Center

Table 3 – Top 10 significant features for 1-LRT and AdaBoost with trees.

1-LRT		AdaBoost with trees	
Counts	Feature name	IS ($\times 10^{-4}$)	Feature name
1591	*Age*	0.6462	*Diagnosis of diabetes mellitus w/o complications, 1 year before the target year*
548	*Visit to the Emergency Room, 1 year before the target year*	0.5498	*Diagnosis of heart failure, 1 year before the target year*
525	Diagnosis of hematologic disease, 1 year before the target year	0.4139	*Age*
523	*Diagnosis of heart failure, 1 year before the target year*	0.3187	*Symptoms involving respiratory system and other chest symptoms, 1 year before the target year*
514	*Symptoms involving respiratory system and other chest symptoms, 1 year before the target year*	0.2470	Admission due to other circulatory system diagnoses, 1 year before the target year
486	*Diagnosis of diabetes mellitus w/o complications, 1 year before the target year*	0.2240	Visit to the Emergency Room, 4 years before the target year and the rest of the history
474	Lab test CPK, 1 year before the target year	0.1957	Operations on cardiovascular system (heart and septa OR vessels of heart OR heart and pericardium), 4 years before the target year and the rest of the history
451	Lab test CPK, 4 years before the target year and the rest of the history	0.1578	*Visit to the Emergency Room, 1 year before the target year*
408	*Diagnosis of heart failure, 2 years before the target year*	0.1543	Symptoms involving respiratory system and other chest symptoms, 4 years before the target year and the rest of the history
356	Diagnosis of diabetes mellitus w/o complications, 2 years before the target year	0.1124	*Diagnosis of heart failure, 2 year before the target year*

Dai W et al. Int J Med Inform. 2015;84:189

사업목표 및 추진방향

AMIS 3.0 in AMC

1 사업 목표

진료, 연구, 교육 및 관리 등 병원 전체 부문에서 실시간 상호 업무 연계와 정보공유가 가능한

사용자 중심의 통합의료정보시스템을 재구축 하여 신속한 업무 처리와

의사결정이 가능하도록 하는 것

2 추진방향

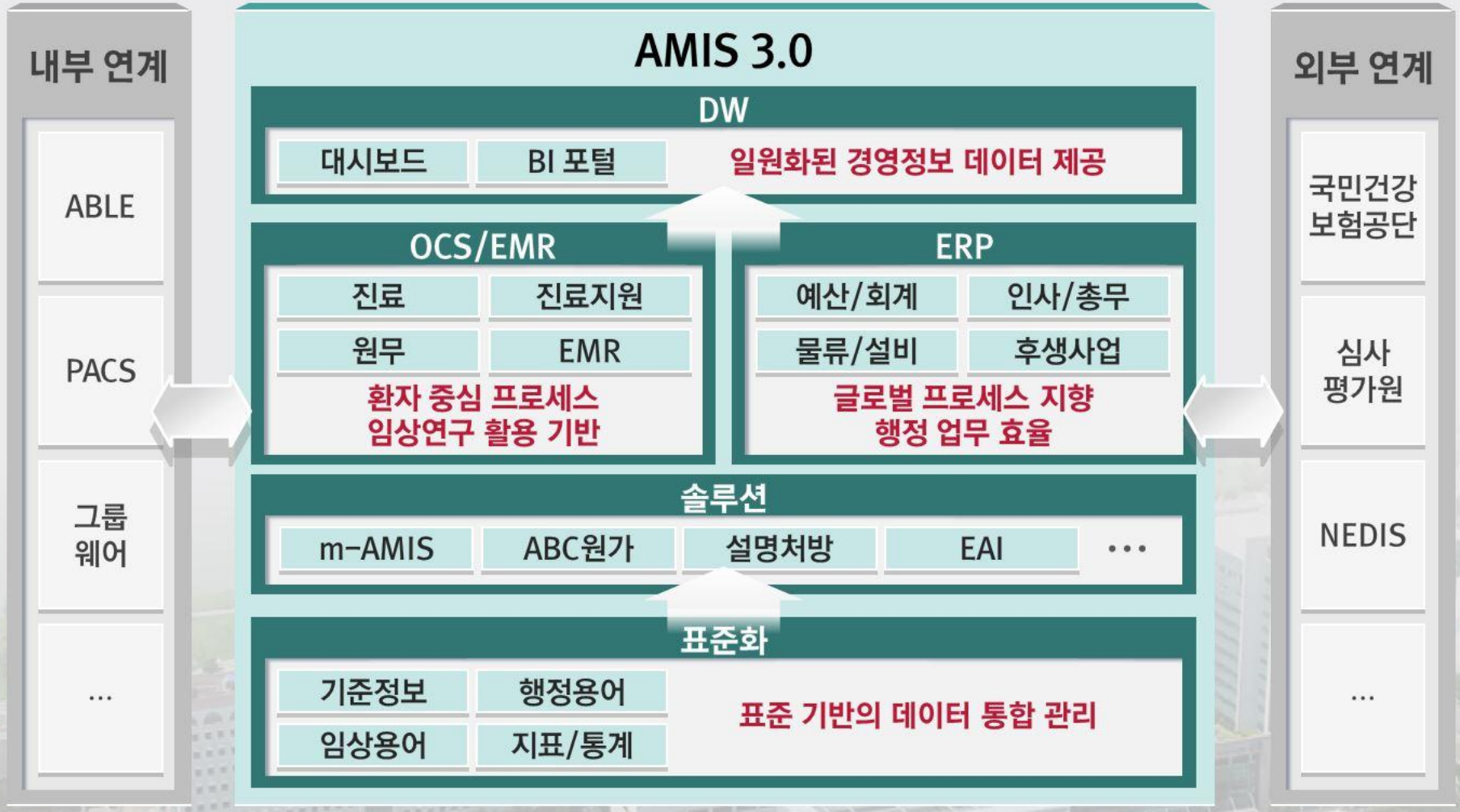
미래지향적 IT 인프라에 기반한 글로벌 표준 통합의료정보서비스를 제공함으로써

고객 중심, 연구중심, 사용자 중심의 최적화된 진료서비스 수행과 함께

경영 혁신에 기여한다

구축범위

- OpenEHR 을 활용한 Clinical Content Model 을 적용
- CCM 은 임상데이터를 논리적으로 구성해 환자 자료 입력을 보다 편리하고 정확하게 지원할 뿐만 아니라, 입력된 자료를 재활용(임상의사결정지원, 연구분석, 임상문서 저작 등)



주) BI : Business Intelligence, EAI : Enterprise Application Integration

구축일정

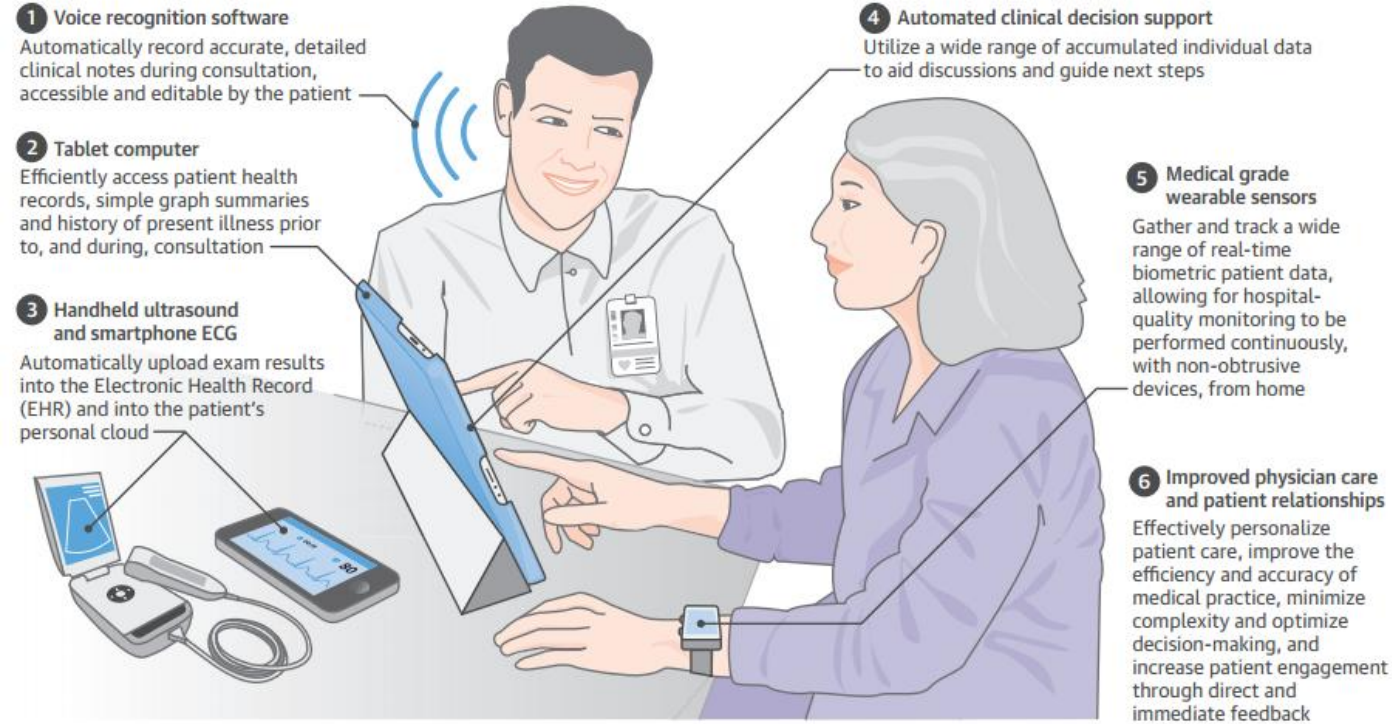

계약 15.07
착수 보고 (8/10)
분석말 보고 15.12
설계말 보고 16.03
구축말 보고 16.09
Open (17.2.1)
완료 보고 17.04
총 22개월
착수
분석
기본설계
설계
선행개발
개발
테스트
안정화
OCS
DW
표준화
인프라
1
•현업인터뷰
•업무시나리오
분석
113개 그룹
(진료과49개)
2
프로토타입
(화면, UX)
3
부서간 합의
4
현업 제3자
기능 테스트
5
•통합테스트 3회
•리허설 3회
선행개발
설계
비핵심개발
통합테스트
지표 표준화
프로토타입
보고서
정의
모델링
데이터 적재
개발
통합
테스트
착수
표준체계 확정
관리체계 확정
모델링
기준정보개발
통합테스트
분석
개발환경
구축
선도개발
운영환경
구축
성능테스트
통합테스트
리허설 지원
안정화

Device / remote Monitoring

- Capture and analyze in real-time large volumes of fast-moving data from in-hospital and in-home devices, for safety monitoring and adverse event prediction
- Particularly useful for chronically ill patients, such as diabetes, hypertension, chronic heart failure, and analyzing the resulting data to monitor adherence (determining if patients are actually doing what was prescribed) and to improve future drug and treatment options

Moving From Digitalization to Digitization in Cardiovascular Care

Why Is it Important, and What Could it Mean for Patients and Providers?



INDIVIDUALIZING PATIENT CARE

Steinhubl, S.R. et al. J Am Coll Cardiol. 2015; 6613:1489

Dr. M Project by KAIST with AMC

ICT system + Medical care

(1) Real-time monitoring, transmission and storage of heal information
(2) Development of mobile / wireless medical devices
(3) Disease diagnosis and prediction with personalized medicine
(4) Health care business mode

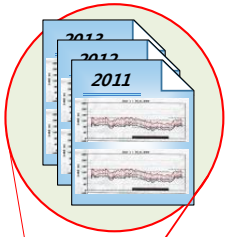
Dr. M process

[6] Business model

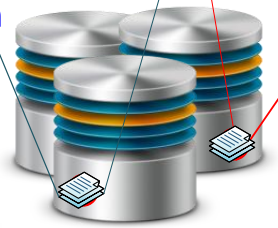
[4] Disease diagnosis and prediction

Disease knowledge

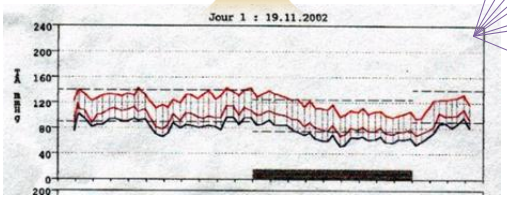
Historical Data



[5] Identification of new medical knowledge



DrM Database

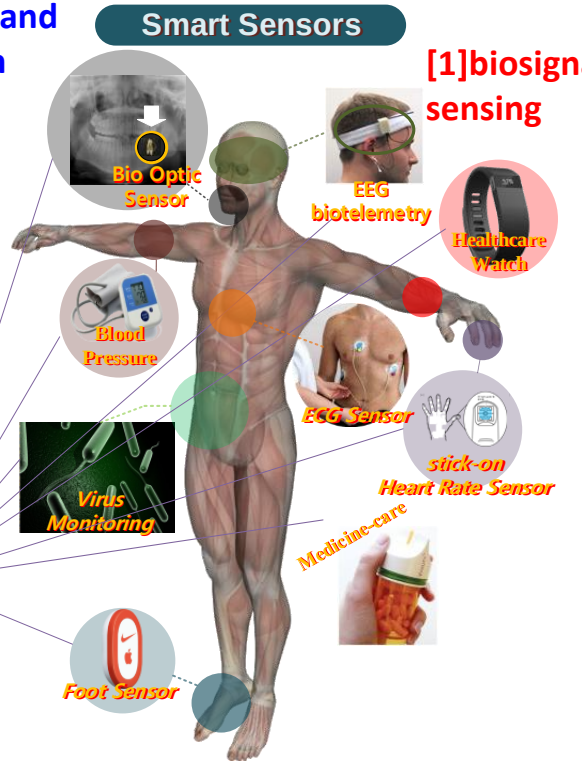


Real-time Monitoring Data

[3] IoT platform and data analysis

Smart Sensors

[1]biosignal sensing



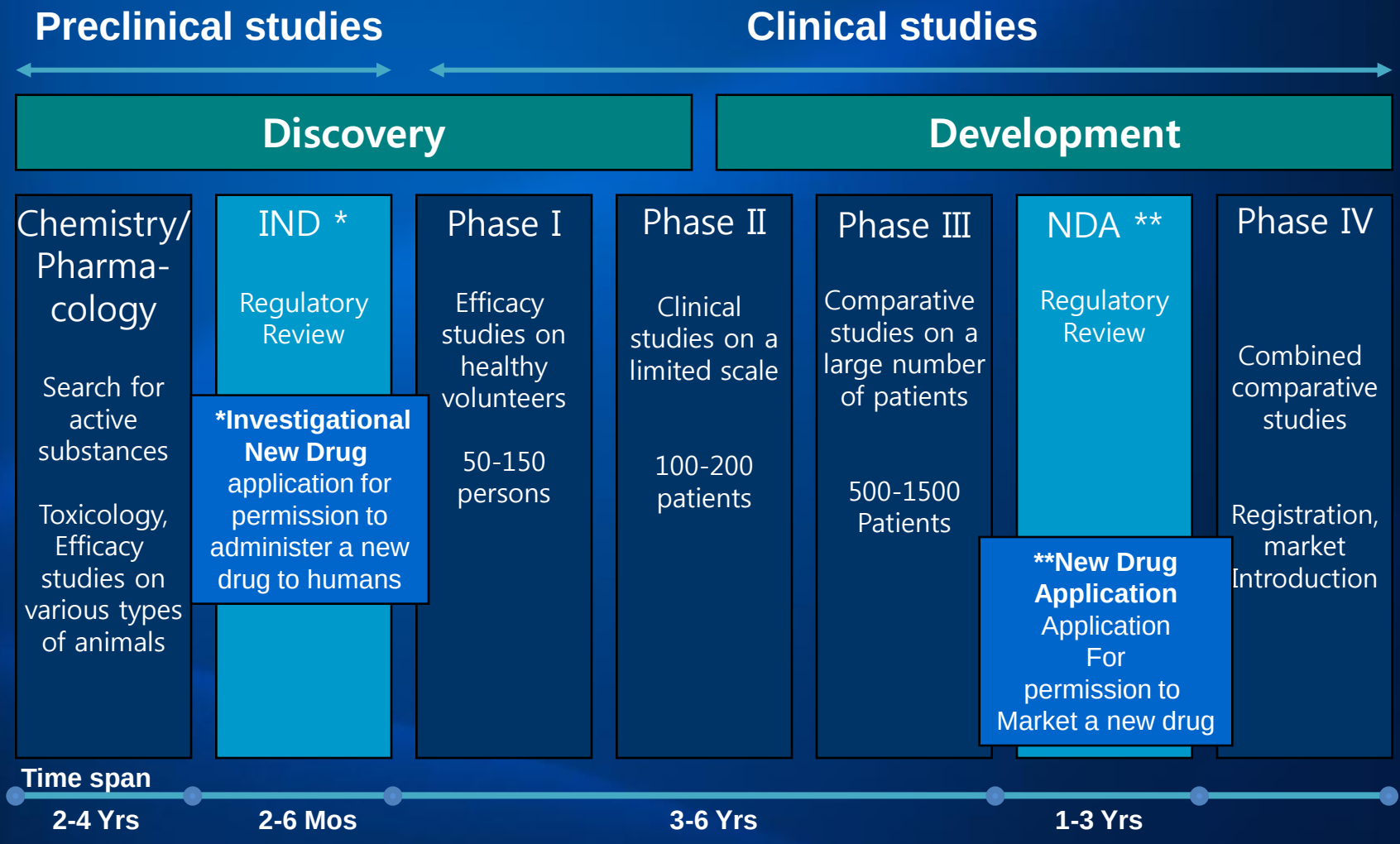
[2] low-voltage transmission, IPv6

doctor MOBILE HEALTHCARE INNOVATION

Research & Development

- Predictive modeling to lower attrition and produce a leaner, faster, more targeted R & D pipeline in drugs and devices
- Statistical tools and algorithms to improve clinical trial design and patient recruitment to better match treatments to individual patients, thus reducing trial failures and speeding new treatments to market
- Analyzing clinical trials and patient records to identify follow-on indications and discover adverse effects before products reach the market.

R & D Process of New Drug (approx. 13 years)



Reduction of 3 to 5 years in the pre-clinical phase by using big data

McKinsey Global Institute 2011

VIEWPOINT

Is Big Data the New Frontier for Academic-Industry Collaboration?

Sample Projects From the Merck-Regenstrief Partnership

Methods for Observational Research

Melanoma phenotype algorithm[a] development and validation

Surveillance of acute myocardial infarction associated with antidiabetic agents

Calibrating evidence of drug risk by estimating database bias

Clinical Data Analysis

Adherence in respiratory disorders

Usage, benefits, and adverse effects of diuretics in heart failu

Longitudinal modeling of heart failure progression

Outcomes of bisphosphonate treatment in adherent patients

Renal impairment in osteoporosis

Disparities in osteoporosis treatment

Diagnosis of atypical subtrochanteric fractures

Health Information Technology

Natural language processing core pipeline for clinical documents

Electronic patient-reported outcomes (ePRO) capture platform

Clinical Interventions

Adherence protocol for adults with mild cognitive impairment

Human papillomavirus vaccination: an investigation of physician reminders and recommendation scripts

Hypoglycemia risk calculator for use in clinical practice

[a] In studies of real-world data, there is a need to validate the phenotypes represented in the clinical data; the appropriate choice of phenotype is critical in ensuring the accuracy of observational data analysis.

Journal of American Medical Association 2014;311:2171

Issues for Medical Big Data Utilization

- Security
- Privacy
- Network management
- Storage
- Information management and analytics
- Validation for clinical use
- …

Cardiovascular Healthcare Big Data Research

Data Gathering

Data Analysis

Clinical Validation

Healthcare Big Data Platform

Multicenter EMR, Public DB

- ✓ 심혈관질환 데이터 항목 정의 및 수집
- ✓ 청구 및 건강검진 데이터

서울아산병원 Asan Medical Center

국민건강보험공단 National Health Insurance Corporation

Lifelog DB

- ✓ Wearable 장비를 통한 자가 측정 정보
- ✓ 기상청, 환경부 등 외부 데이터 연동

기상청 Korea Meteorological Administration

환경부

CDSS for CV Research

- ✓ 심장마비 사전 예측 기술
- ✓ 심질환 진단 정확도 증가 기술
- ✓ 심혈관계 질환 위험도 예측
- ✓ 급성 부정맥 사전 예측
- ✓ 약제 순응도 및 부작용 모니터링.예측

서울아산병원 Asan Medical Center

- ✓ 개발 모델의 임상적 유용성 확인을 위한 임상시험 수행

Clinical Trial

- ✓ 힐링 플랫폼을 활용한 기반 인프라 및 API 개발
- ✓ 클라우드 기반 분석 platform 개발
- ✓ 예측모델 기반 개인별 위험도 서비스
- ✓ 국제 표준 기반 데이터 통합 및 전송

Infrastructure

- ✓ 의료 빅데이터 관리를 위한 정보 보호/보안 기술 개발
- ✓ 의료정보 익명화 기술 개발

Security / Privacy

감사합니다.

Asan Medical Center
Young-Hak Kim