


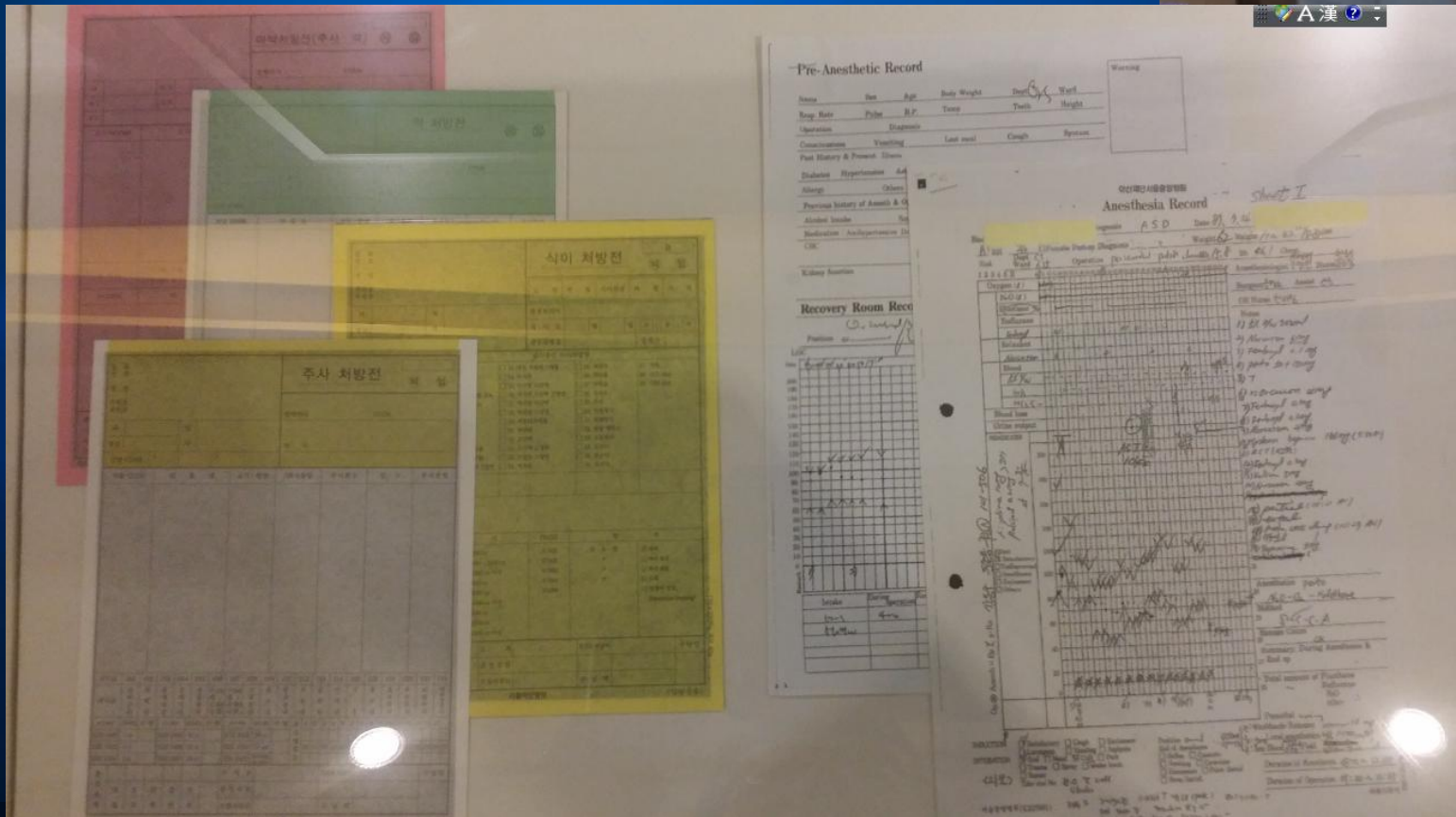
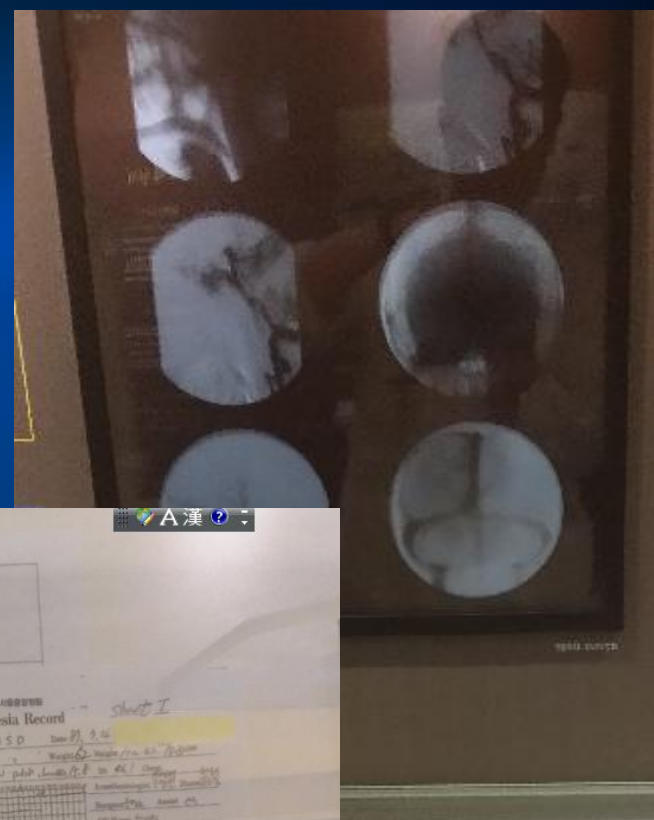
Utilization of Medical Bid Data for Cardiovascular Healthcare



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

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



Electronic Medical Record (EMR)

The screenshot displays a comprehensive EMR system interface. At the top, a menu bar provides navigation options. The left sidebar allows users to switch between different data views. The central workspace is the primary area for entering and reviewing patient information, including medical history and current issues. The right sidebar is dedicated to the active record, showing a list of problems and the current assessment. The interface is designed for efficient data entry and retrieval in a clinical setting.

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

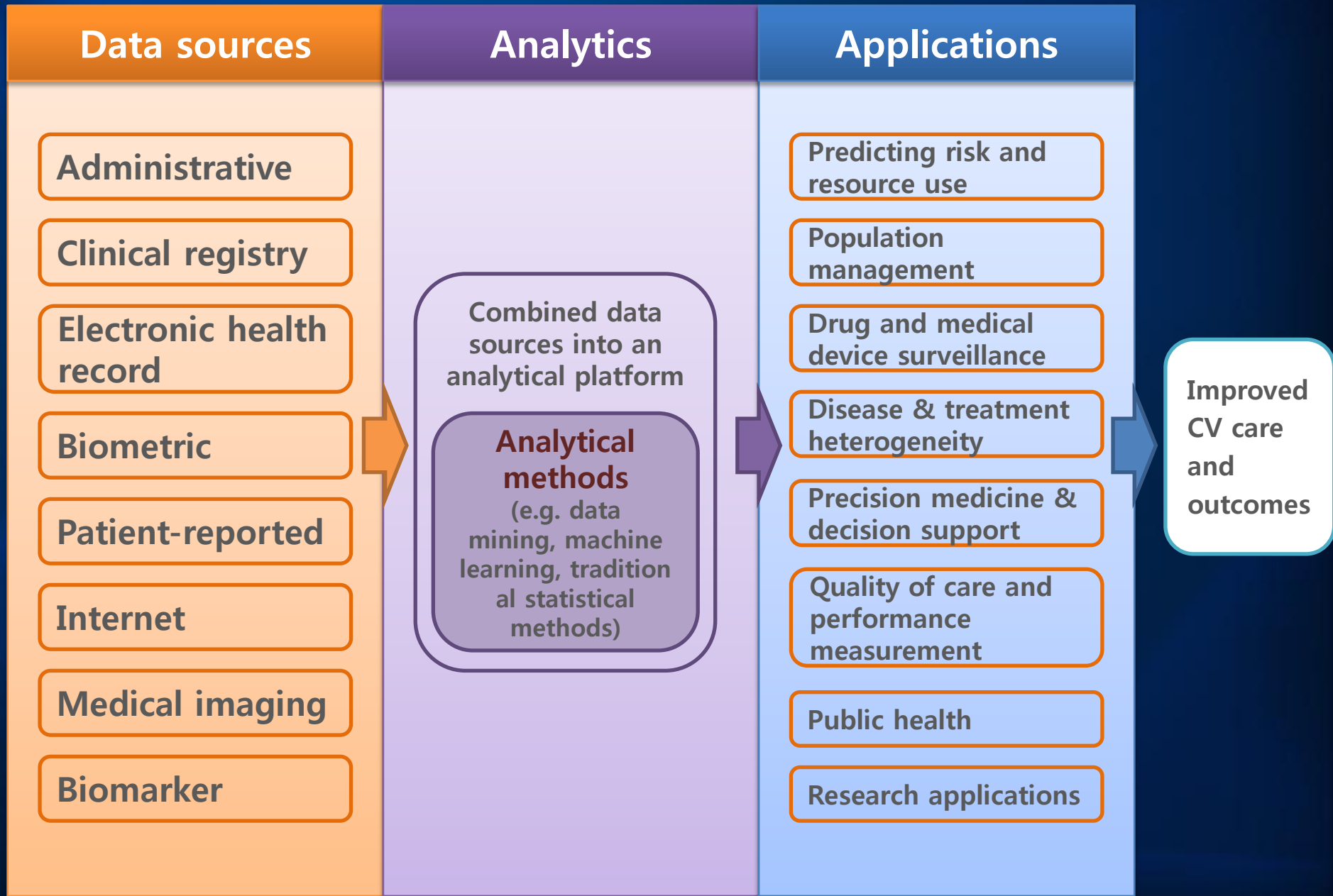
- Public data



- EMR
- Image
- Genetic information
- ...



- Lifelog data
- Mobile device
- ...



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

Utilization of Medical Big Data

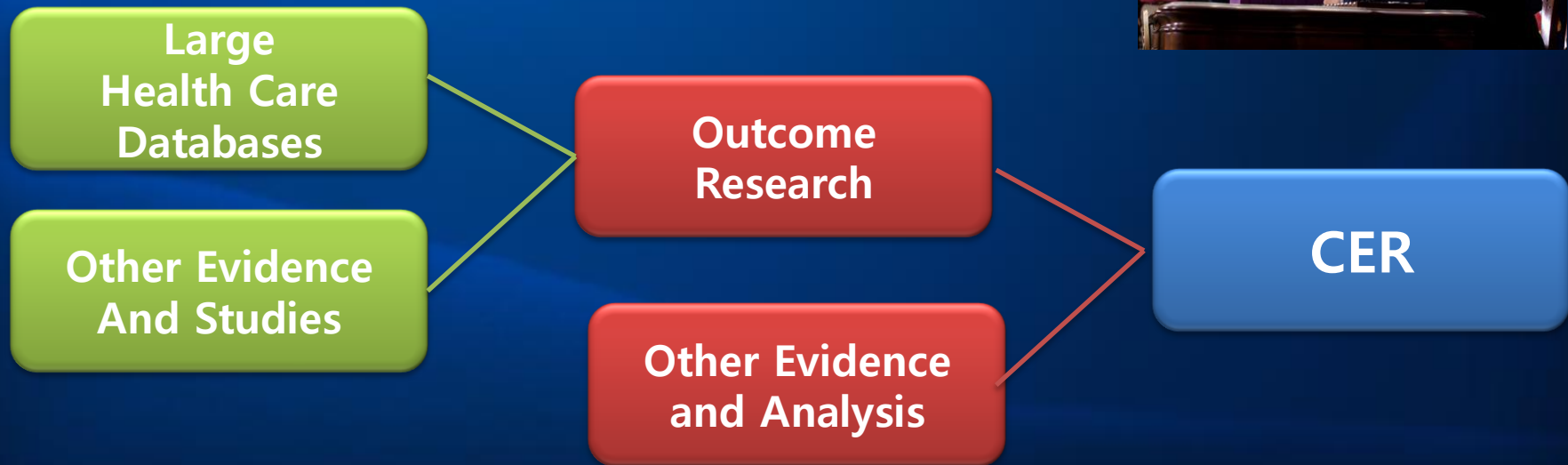
1. **Clinical operation**
2. Research & development
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5. Genomic analytics
6. Pre-adjudication fraud analysis
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Clinical Operations

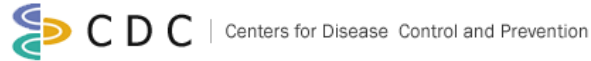
- **Comparative effectiveness research (CER)**
- **Clinical decision support system (CDSS)**

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



[About CDC](#) | [Centers and Divisions of CDC](#) | [Korean Influenza Surveillance Scheme](#) | [National Stem Cell Bank](#) | [Major Project Related Website](#)
[Stem Cell Registry](#) | [National Stem Cell Bank](#)

Achieving a Healthier Korea!
Centers for Disease Control & Prevention
Leading the Way to disease-free world

About CDC

- Introduction
- Greetings from the Director
- Milestone
- Vision & Organization Chart

Centers and Divisions of CDC

- Center for Infectious Disease Control
- Center for Disease Prevention
- Center for Infectious Disease
- Center for Immunology and Pathology
- Center for Biomedical Science
- Center for Genome Science
- Korean Network for Organ Sharing (KONOS), General Affairs Section
- Division of Research Planning
- Division of Biosafety Evaluation & Control

Major Project Related Website



(28159) Osong Health Technology Administration Complex, 187, Osongsaengmyeong 2-ro, Osong-eup, Heungdeok-gu, Cheongju-si, Chungcheongbuk-do, Korea | Tel. +82-43-719-7700
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Public data for CER

The screenshot shows the top portion of the HIRA website. At the top left is the HIRA logo (a stylized 'X' shape) followed by the text "HIRA HEALTH INSURANCE REVIEW & ASSESSMENT SERVICE". On the top right, there are links for "KOREAN", "Send e-mail", and "Contact us". Below this is a navigation bar with links for "Home", "About HIRA", "International Cooperation", and "News & Information", along with a search box containing the text "What are you looking for?". The main banner features the "h·well NHIS National Health Insurance Service" logo on the left, a navigation menu with links for "About Us", "Social Security System of Korea", "NHI Program", "Long-Term Care Insurance", "Health Insurance Guide", "Community", and "Training Course on SHI", and a large central image with the text "Welcome to the National Health Insurance Service" and "Our National Health Insurance Service is a leading health insurance".

The screenshot shows the Statistics Korea website. The header includes the "STATISTICS KOREA" logo and a search bar. Below the header is a navigation bar with links for "Press Releases", "Survey Outline", "Resources", "News", "Help", and "About KOSTAT". The main content area is divided into three columns. The left column, titled "Latest Indicators", shows three indicators: "Retail Sales" (Month-on-Month, Nov. 2015) with a -1.1% change, "Industrial Production" (Month-on-Month, Nov. 2015) with a -2.1% change, and "Consumer Prices" (Month-on-Month, Dec. 2015). The middle column, titled "Press Releases", features a highlighted article titled "Economically Active Population Survey in December ..." dated 2016-01-13, with a brief description: "[Economically active population and labor force participation rate] - The economically active population marked ...". The right column, titled "Survey Outline", displays a grid of icons representing various survey categories: Agriculture, Forestry and Fisheries; Business Trends; Corporate Business; Employment and Labour; Health and Society; and Household Economy.

□ '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 미만이라도, 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

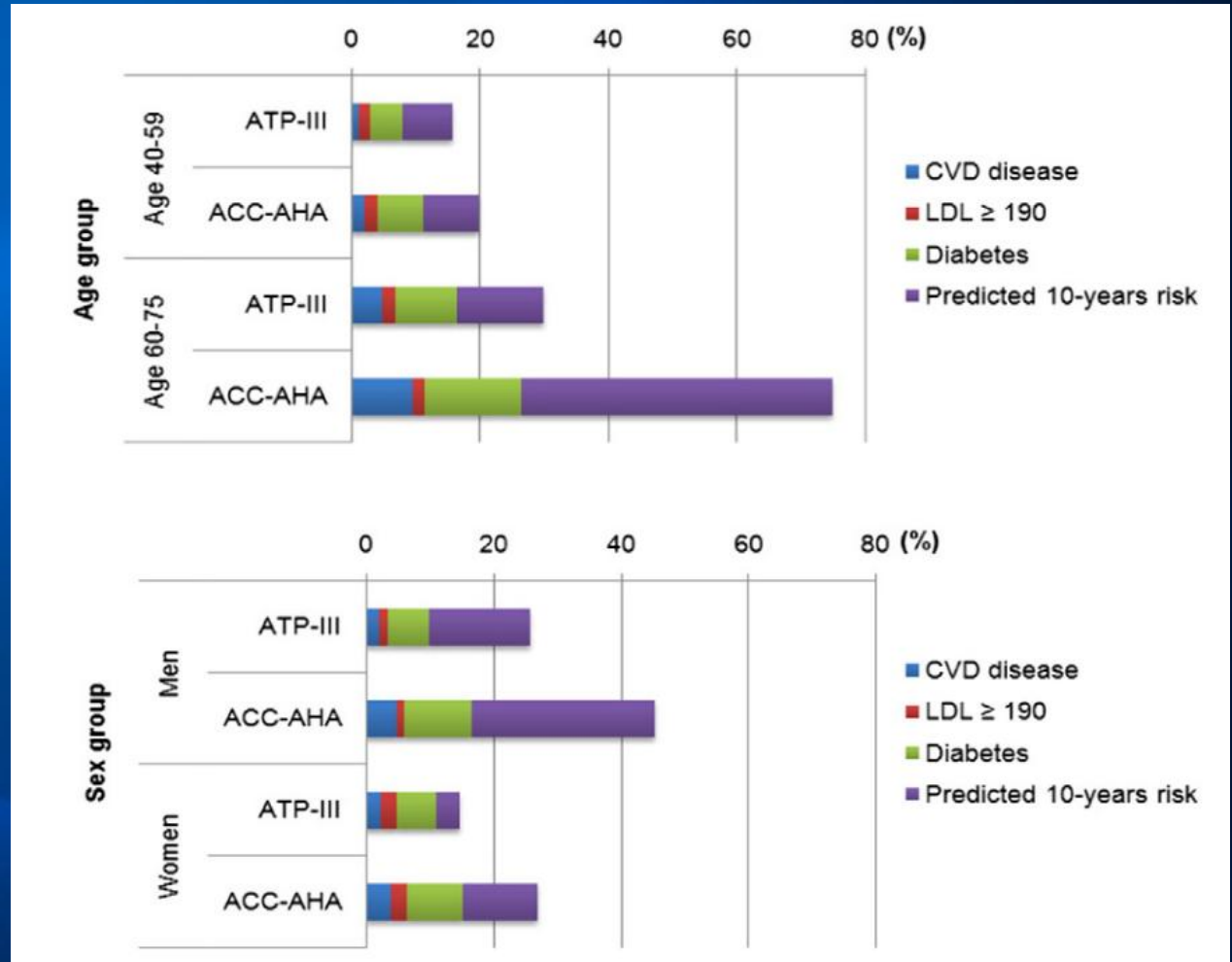
정부정책 추진의 아젠다 제시 및 과학적 근거 지원, 연구 결과에 근거한 고시변경, 급여변경, 특정 법령의 제·개정 등 정책 및 제도 개선에 직접적으로 활용 가능한 사항, 보건재정의 효율적 사용을 위한 근거 제시, 임상현장 진료 결정기준 변경

▶ 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

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

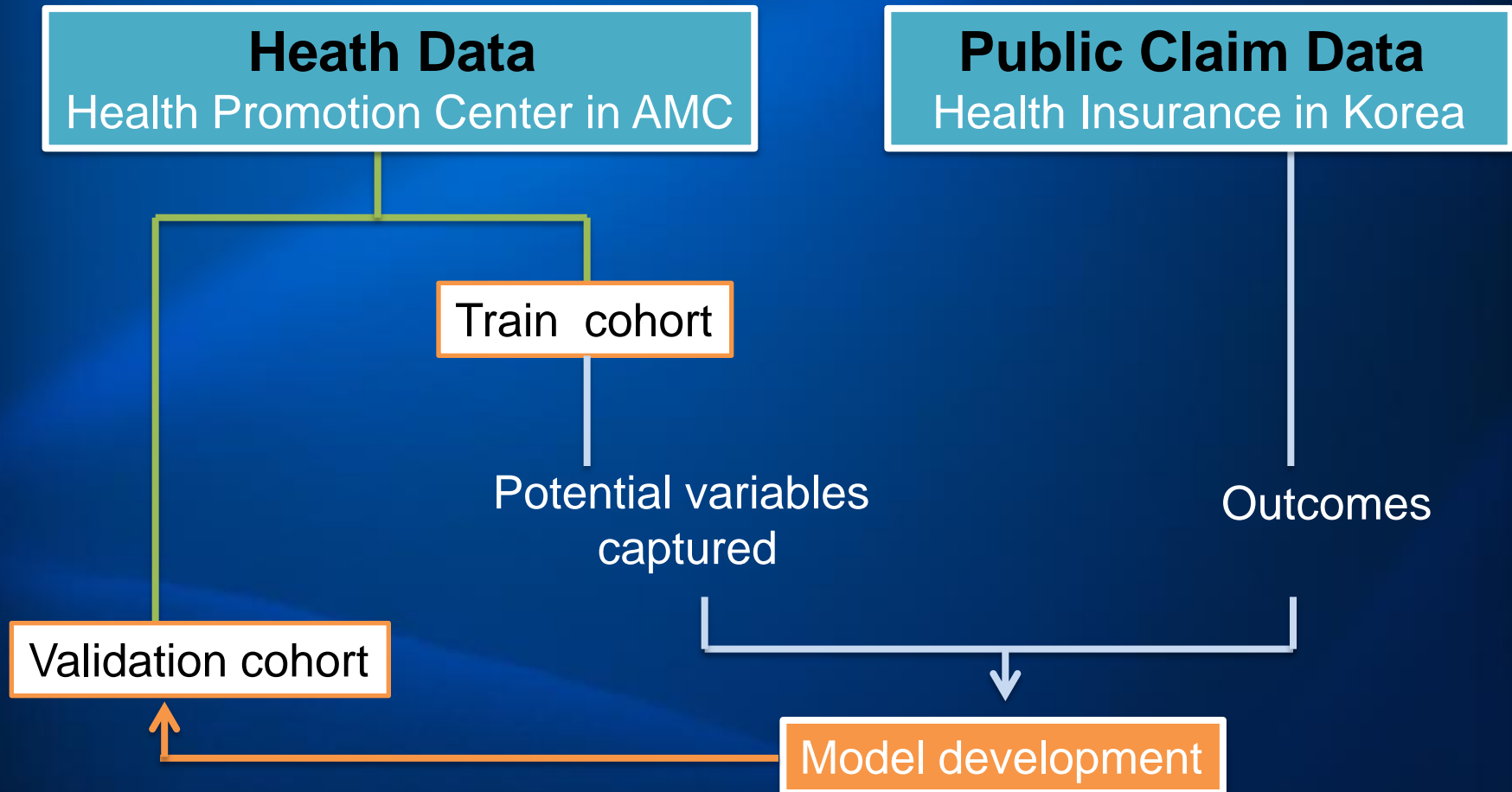
The screenshot shows the ASAN Medical Center website. The header includes the ASAN Medical Center logo and navigation links: International Healthcare Service, Centers & Departments, Education & Research, and About AMC. The main content area is titled "Health Screening and Promotion Center" and includes a "List of Center" button. Below this is a navigation bar with "About Center", "Customized Medical Program", "Medical Staff", and "Appointment". The "About Center" section describes the center's history, location, and services, mentioning that it has opened in 1990 and moved to East Building in 1996. It also lists various medical services and facilities. The "Facilities" section includes an aerial view of the center and lists features such as 6.612m² (71,171sqft) of dedicated facility space, separate test areas for men and women, hotel-type rooms for overnight screening, an art gallery space, a guest lounge, and a health medicine department.

The screenshot shows the HIRA website. The header includes the HIRA logo and navigation links: Home, About HIRA, International Cooperation, News & Information, and a search bar. The main content area is titled "Benefit Management" and includes a sub-header "Benefit Management" and a paragraph explaining the Ministry of Health and Welfare's role in determining medical services covered under the National Healthcare Insurance Act. Below this is a "more" button. The "International Cooperation" section includes a "Symposium" section with a "2014 International Seminar" and a "Training Course" section with a "2015 HIRA Training Course on Social Health Insurance Location". The "Foreign Delegation" section includes a "2015 HIRA Training Course on Social Health Insurance Location" and a "Implementing Arrangement" section. The footer includes "About HIRA", "International Cooperation", and "News & Information" sections with various links and activities.

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

Model Development and Validation



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

Modeling

13 possible scenario models in the train cohort

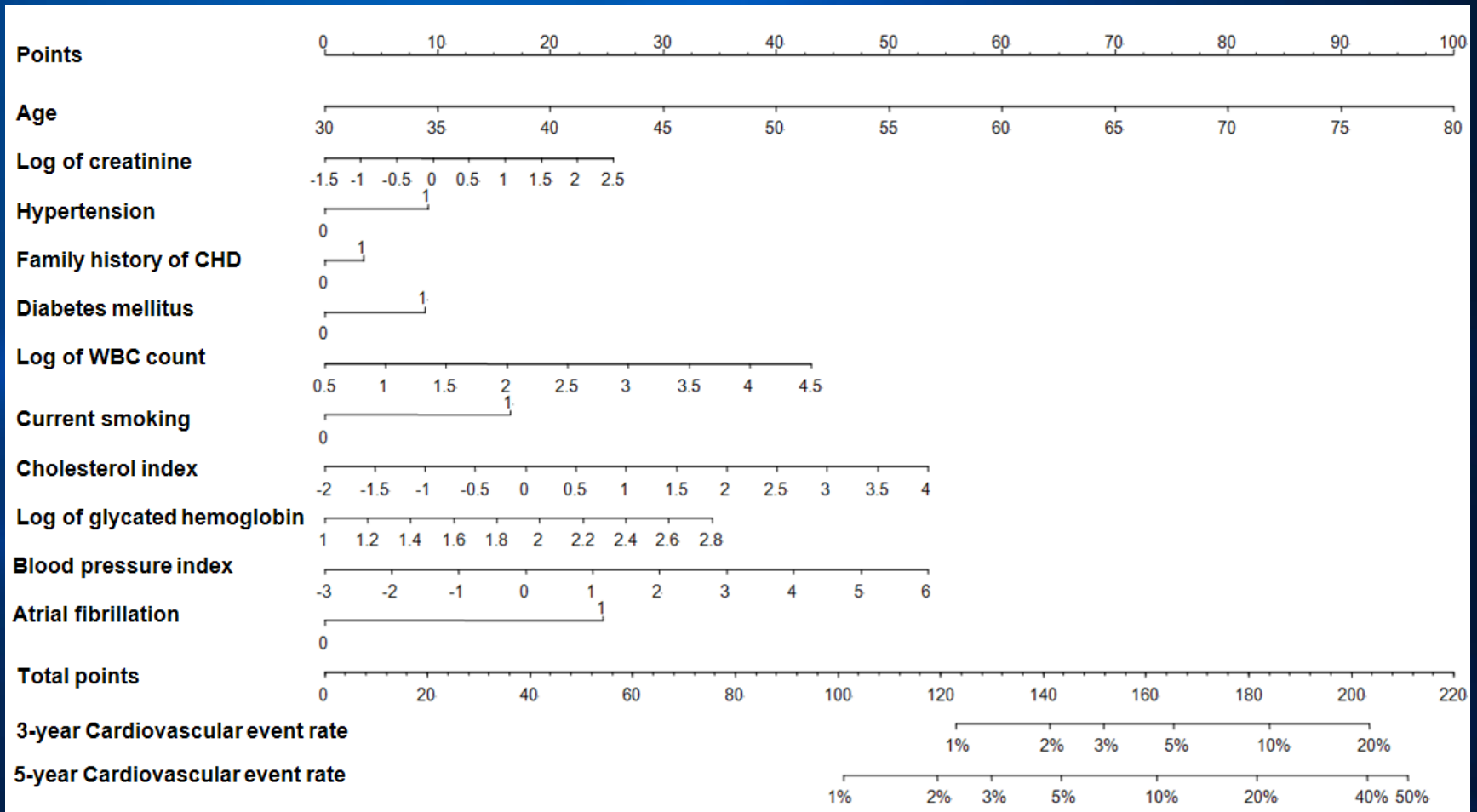
Table II. Performance of the Possible Scenario Models for Cardiovascular Disease in the Train Cohort.*

Models	Variables	Coefficient	Shrinkage
1	Framingham risk model for 10-year CHD	11.877	0.7
	C-index (95% confidence interval)		
	Akaike Information Criterion		
	Shrinkage		
2	Framingham risk model for 10-year CVD	6.778	0.6
	C-index (95% confidence interval)		
	Akaike Information Criterion		
	Shrinkage		
3	Age	0.083	0.6
	C-index (95% confidence interval)		
	Akaike Information Criterion		
	Shrinkage		
4	Age	0.081	0.7
	Log of creatinine	1.111	
	C-index (95% confidence interval)		
	Akaike Information Criterion		
5	Age	0.070	0.7
	Log of creatinine	0.958	
	Hypertension	0.655	
	C-index (95% confidence interval)		
6	Age	0.066	0.7
	Log of creatinine	1.007	
	Hypertension	0.606	
	Log of erythrocyte sedimentation rate	0.215	
7	Age	0.068	0.7
	Log of creatinine	0.923	
	Hypertension	0.602	
	Log of erythrocyte sedimentation rate	0.175	
8	Age	0.074	0.7
	Log of creatinine	0.556	
	Hypertension	0.343	
	Family history of CHD	0.140	
9	Age	0.072	0.7
	Log of creatinine	0.141	
	Hypertension	0.368	
	Log of erythrocyte sedimentation rate	0.162	
10	Age	0.075	0.7
	Log of creatinine	0.146	
	Hypertension	0.245	
	Log of erythrocyte sedimentation rate	0.230	
11	Age	0.075	0.7
	Log of creatinine	0.146	
	Hypertension	0.245	
	Log of erythrocyte sedimentation rate	0.230	
12	Age	0.072	0.7
	Log of creatinine	0.141	
	Hypertension	0.368	
	Log of erythrocyte sedimentation rate	0.162	
13	Age	0.072	0.7
	Log of creatinine	0.141	
	Hypertension	0.368	
	Log of erythrocyte sedimentation rate	0.162	

Model	Variables	Coefficient	Shrinkage				
8	New built Framingham risk model for CHD		0.7				
	Age	0.074					
	Low-density lipoprotein cholesterol	0.556					
	High-density lipoprotein cholesterol	0.343					
	Diabetes mellitus	0.140					
	Current smoking	0.366					
	Categorized blood pressure	0.279					
	Normal	0.686					
	Optimal	0.214					
	High normal	0.501					
	Grade1	0.255					
	Grade2	0.795					
	Grade3	0.214					
9	Gender	0.279	0.7				
	C-index (95% confidence interval)	0.757 (0.726-0.788)					
	Akaike Information Criterion	7207					
	Shrinkage	0.969					
	10	Age		0.072	0.7		
		C-index (95% confidence interval)		0.755 (0.724-0.787)			
		Akaike Information Criterion		7207			
		Shrinkage		0.969			
		11		Age		0.072	0.7
				C-index (95% confidence interval)		0.751 (0.719-0.782)	
				Akaike Information Criterion		7219	
				Shrinkage		0.974	
				12		Age	
C-index (95% confidence interval)			0.751 (0.719-0.782)				
Akaike Information Criterion			7219				
Shrinkage			0.974				
13			Age			0.072	
	C-index (95% confidence interval)		0.751 (0.719-0.782)				
	Akaike Information Criterion		7219				
	Shrinkage		0.974				

Model	Variables	Coefficient	Shrinkage
12	New built Framingham risk model for CVD		0.7
	Log of age	3.344	
	Log of total cholesterol	0.560	
	Log of high-density lipoprotein cholesterol	-0.587	
	Log of systolic blood pressure	2.187	
	Treatment of hypertension	-0.008	
	Diabetes mellitus	0.458	
	Current smoking	0.773	
	Gender	-0.016	
	Interaction between log of systolic blood pressure and treatment	0.106	
	C-index (95% confidence interval)	0.751 (0.719-0.782)	
	Akaike Information Criterion	7219	
	Shrinkage	0.974	

Prognostic Nomogram for Korean CV Risk



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		Blood pressure index	-7.5833
Diastolic blood pressure, mmHg			
Atrial fibrillation on ECG		Yes=1 No=0	
White blood cell count, ×10 ³ /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		Cholesterol index	-0.6720
Low-density lipoprotein cholesterol, mg/dL			
High-density lipoprotein cholesterol, mg/dL			
3-year event rate (%)			
Cardiovascular death/MI/Stroke			#NUM!

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	150	Blood pressure index	1.9167
Diastolic blood pressure, mmHg	90		
Atrial fibrillation on ECG	0	Yes=1 No=0	
White blood cell count, $\times 10^3/\mu\text{L}$	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	200	Cholesterol index	0.3782
Low-density lipoprotein cholesterol, mg/dL	130		
High-density lipoprotein cholesterol, mg/dL	40		
5-year event rate (%)			
Cardiovascular death/MI/Stroke	9.4900		

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

[Home](#)
[About](#)
[Contact](#)

Heart Risk Calculator

On the basis of your age and risk for heart disease or stroke, the USPSTF guidelines suggest you **discuss starting aspirin with your doctor.**

23.0%

10-year risk of heart disease or stroke

On the basis of your age and risk for heart disease or stroke, the ACC/AHA guidelines suggest you should be on a **moderate to high intensity statin.**

Based on your age and race, your blood pressure is **poorly-controlled**, and you should initiate lifestyle interventions and consider starting a **thiazide diuretic, ACEI/ARB, or calcium channel blocker.**

Demography	Cholesterol	Blood pressure	Risk factors
Age: 66	Total: 200	Systolic: 150	Diabetes: no
Gender: male	HDL: 40	Diastolic: 90	Smoking: no
Race: not African-American		On medication: yes	

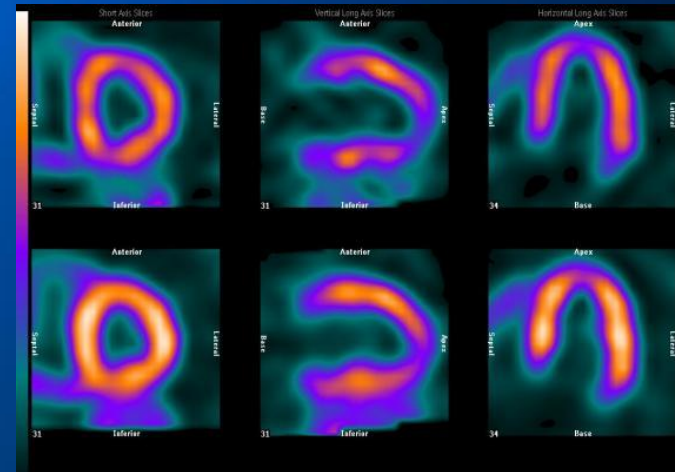
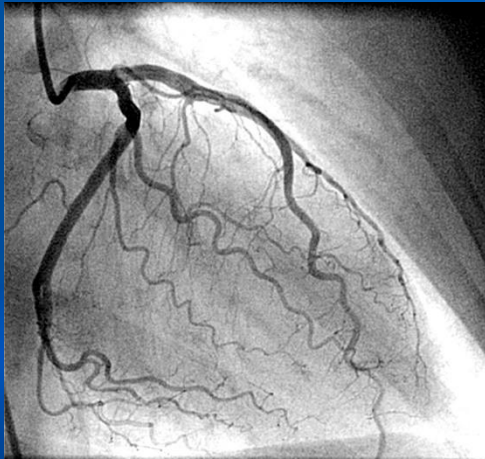
Note: **moderate intensity statin** may be atorvastatin 10mg, pravastatin 40mg, or simvastatin 20-40mg. **High intensity statin** may be atorvastatin 40mg-80mg.

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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.

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

620,512 Patients aged 18 years and older who underwent CAG or MPI examination in a diagnosis of CAD from July 2009 to June 2013

483,446 Excluded

255,978 Primary diagnosis of acute MI or unstable angina
224,113 CAD history in the HIRA database within 6 months
2,313 Exercise ECG or CCTA evaluation within 3 months
1,042 Both CAG and MPI evaluation on the same day

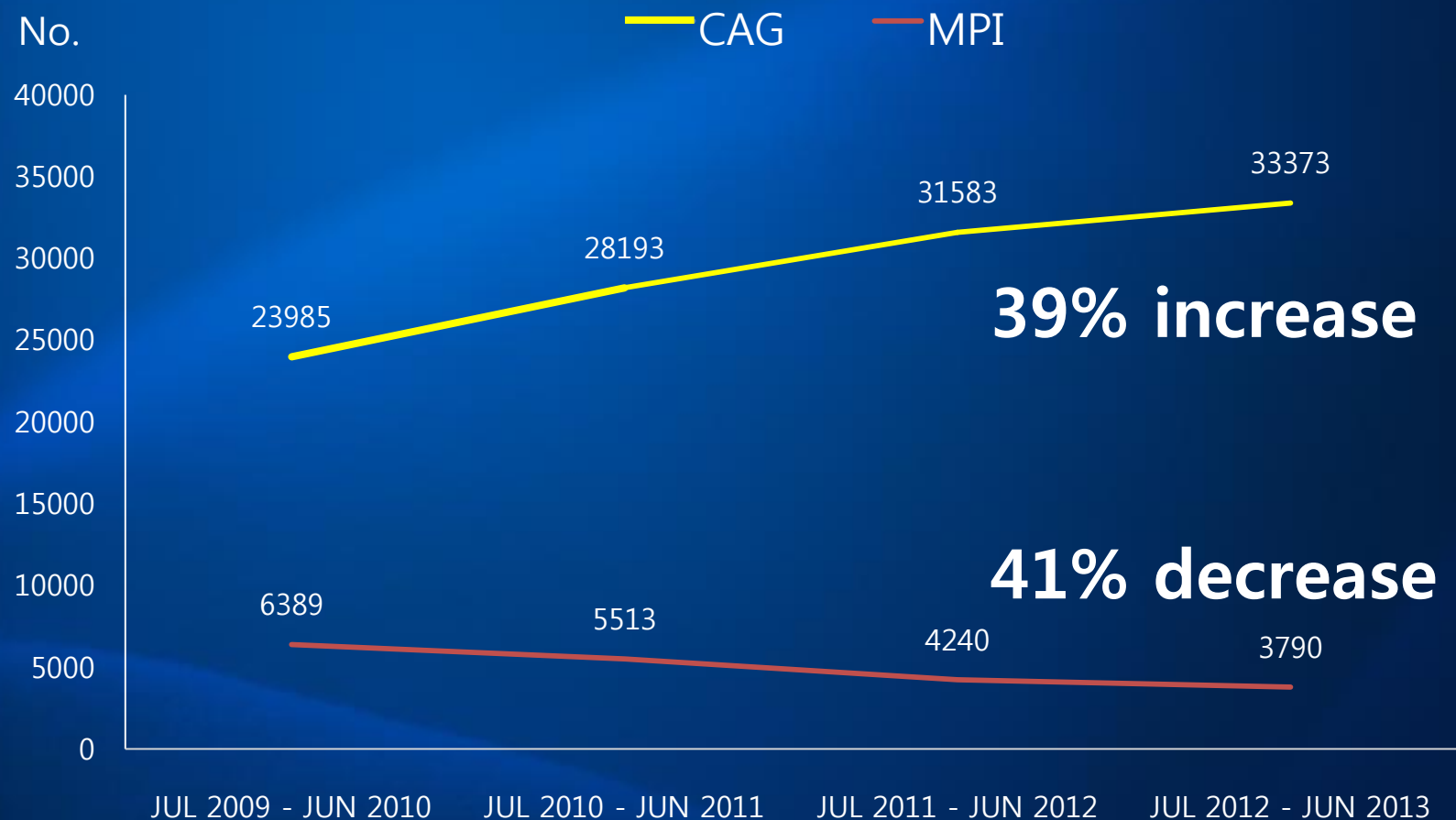
137,066 Included in analysis

CAG group
(N = 117,134)

MPI group
(N = 19,932)

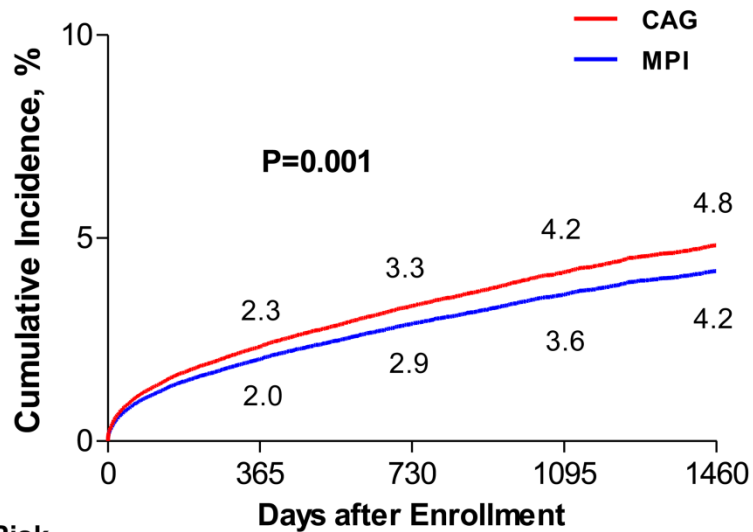
CAG = invasive coronary angiography, MPI = myocardial perfusion imaging

National Trends in the use of CAG vs. MPI



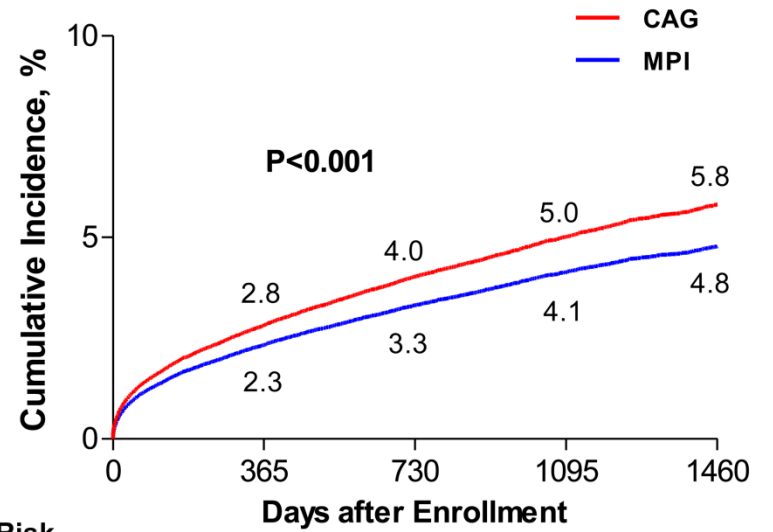
Adjusted Outcomes

Adjusted All-cause Death



No. at Risk	0	365	730	1095	1460
CAG	117134	101077	70294	41323	14383
MPI	19932	17765	12193	7258	2734

Adjusted All-cause Death/Myocardial Infarction



No. at Risk	0	365	730	1095	1460
CAG	117134	100434	69655	40823	14174
MPI	19932	17718	12143	7485	2715

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

심혈관 질환 예방 및 관리방안 마련을 위한 업무협약(MOU) 체결
2016. 2. 23.
h-well 국민건강보험공단 · 심장학회 대한심장학회



국민건강보험공단 이사장
성상철

대한심장학회 이사장
이효희

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

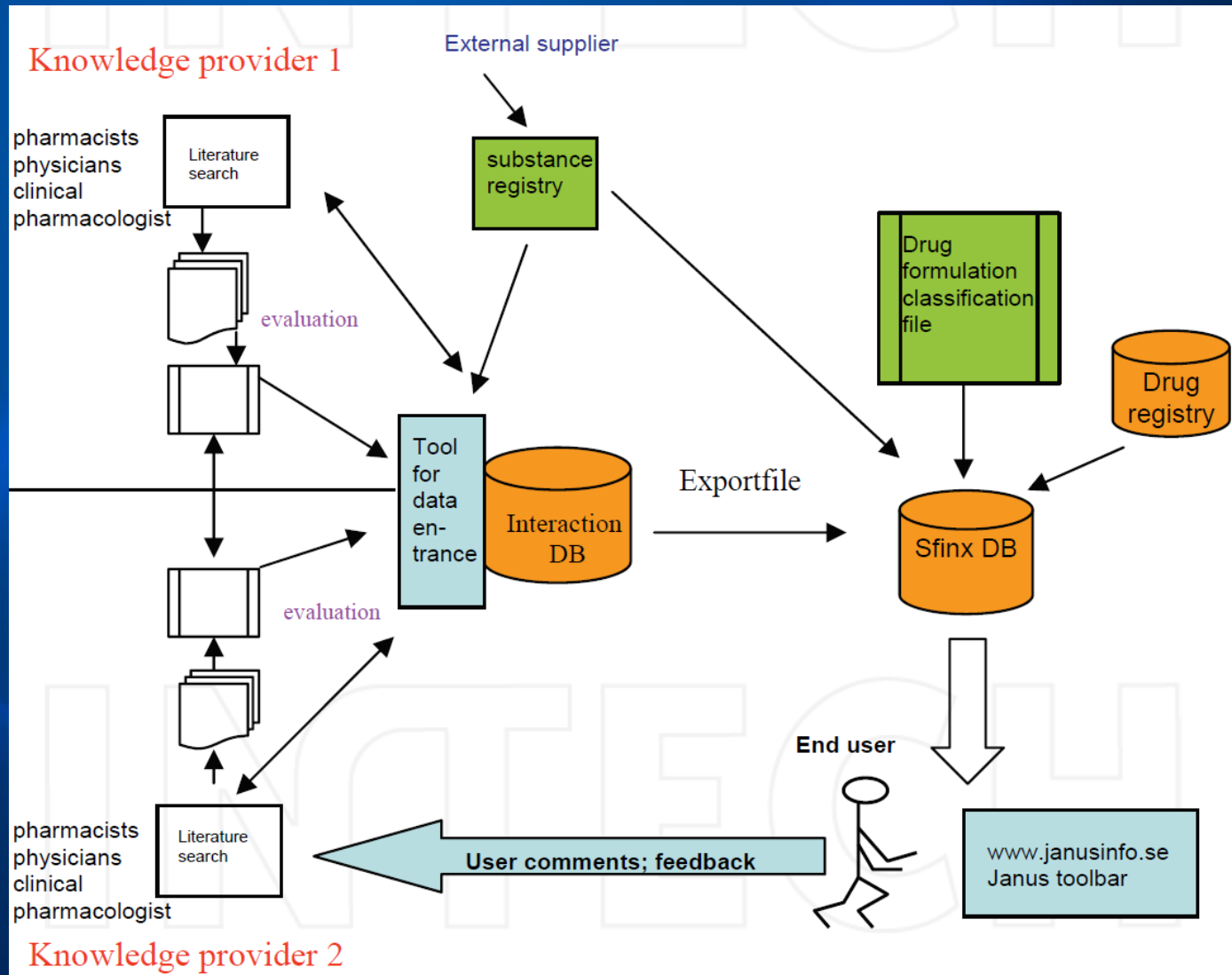


Why CDSS?

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

Knowledge-Based CDSS

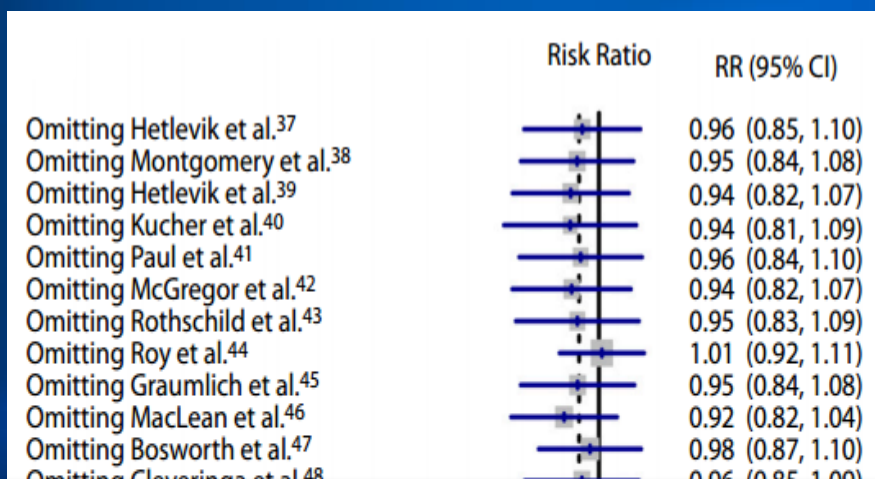


Potential Role of CDSS

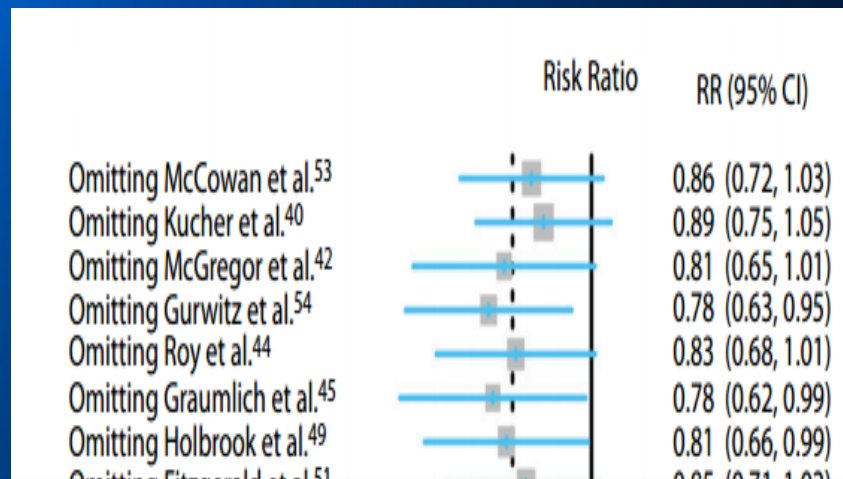
Target Area of Care	Example
Preventive care	Immunization, screening, disease management guidelines for secondary prevention
Diagnosis	Suggestions for possible diagnoses that match a patient's signs and symptoms
Planning or implementing treatment	Treatment guidelines for specific diagnoses, drug dosage 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

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.

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Impact factor, 1.356

Artificial Intelligence in Medicine
Volume 10, Issue 3, Pages 201-287 (July 1997)
Model-based Diagnosis in Medicine
Edited by Peter J.F. Lucas

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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

The screenshot displays a complex medical information system interface. The top menu bar includes options like '환자명단' (Patient List), '국민건강보험' (National Health Insurance), and '환자연동' (Patient Sync). The main window is divided into several panels:

- 진단정보 (Diagnosis Info):** Shows patient ID B353A and diagnosis 'Athlete's foot' and 'Complications and ill-defined descriptions of heart d'.
- 문제목록 (Problem List):** Lists '주 #2 Mass, Rt. cheek' and '주'.
- 수술정보 (Surgery Info):** Details procedures like '장용주' (Septoplasty) and '순병술' (Excisional biopsy).
- 약력정보 (Medication History):** Lists medications such as 'Stogar tab [10mg]' and 'Sudafed tab [60mg]'.
- 내원정보 (Visit History):** Shows a table of patient visits with dates and departments.
- 검사정보 (Exam Info):** Lists various tests including 'CR, Finger Lt AP, Lateral', 'Esophagogastroduodenoscopy', and 'CBC'.
- 결과기록 (Result Record):** Displays a list of test results with checkboxes for viewing details.
- Assessment:** A section for clinical assessment with buttons for 'Plan', '이전투약' (Previous Medication), '전처방' (Previous Prescription), and 'ARC회송' (ARC Return).

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	$\times 10^9/uL$
L2012	RBC	4.51		4.2	6.3	$\times 10^6/uL$
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	$\times 10^9/uL$
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

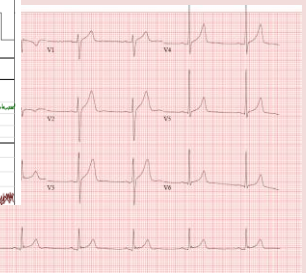
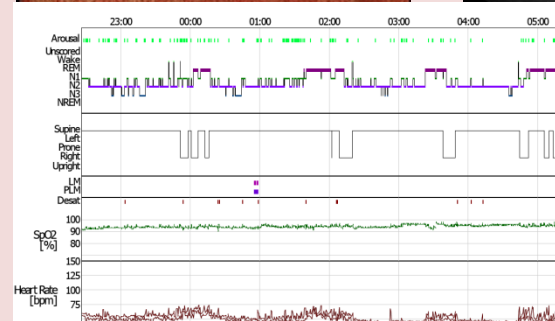
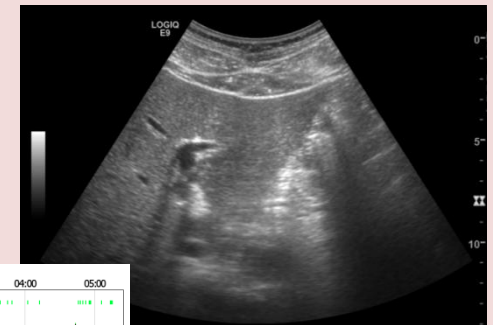
US, Abdomen

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 μ g/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 mL ESV : 19 mL 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 showing 1)
Reversible medium sized **moderately**
 decreased perfusion in **apical-mid anterior**
 wall 2) **Reversible large** sized **mildly**
 decreased perfusion in apical lateral and
mid-basal anterolateral and **mid**
inferolateral wall 3) **Reversible large** sized
mildly decreased perfusion in inferior
 wall 4) **Fixed small** sized **moderately**
 decreased perfusion in **basal inferolateral**
 wall

Pattern recognition

E-cadherin GENIA-Negat Up to 100 targ... Search 1 2 Show All

Pivot Concepts: GeneProt... Target Concepts: Disease

Pattern definition

Reversible	reversible
Irreversible	irreversible
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

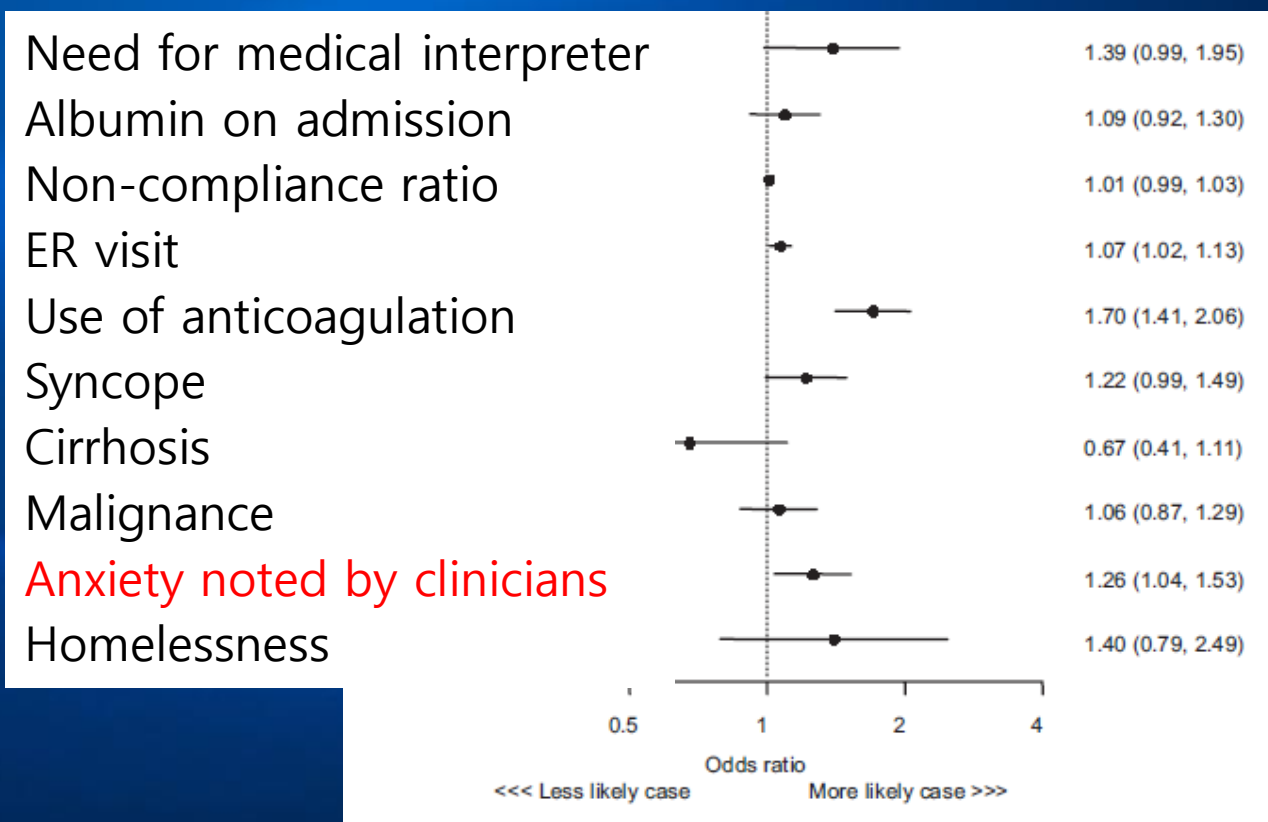
id	acceptYmd	성별	검사시나이	검사코드	검사코드명	결론	결과본문	결과본문순서	SSS	SRS	SDS	SMS	STS	EDV	ESV	LVEF	SMS	STS
1	20140523	F	81	N1085	Thallium S	1) Normal gated myoc	Thallium S	1	2	0	2			67	21	69	0	0
2	20110317	M	76	N1085	Thallium S	Abnormal gated myoc	Thallium S	1	12	0	12			67	28	57	1	2
2	20130724	M	79	N1085	Thallium S	Abnormal 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)



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

1 사업목표

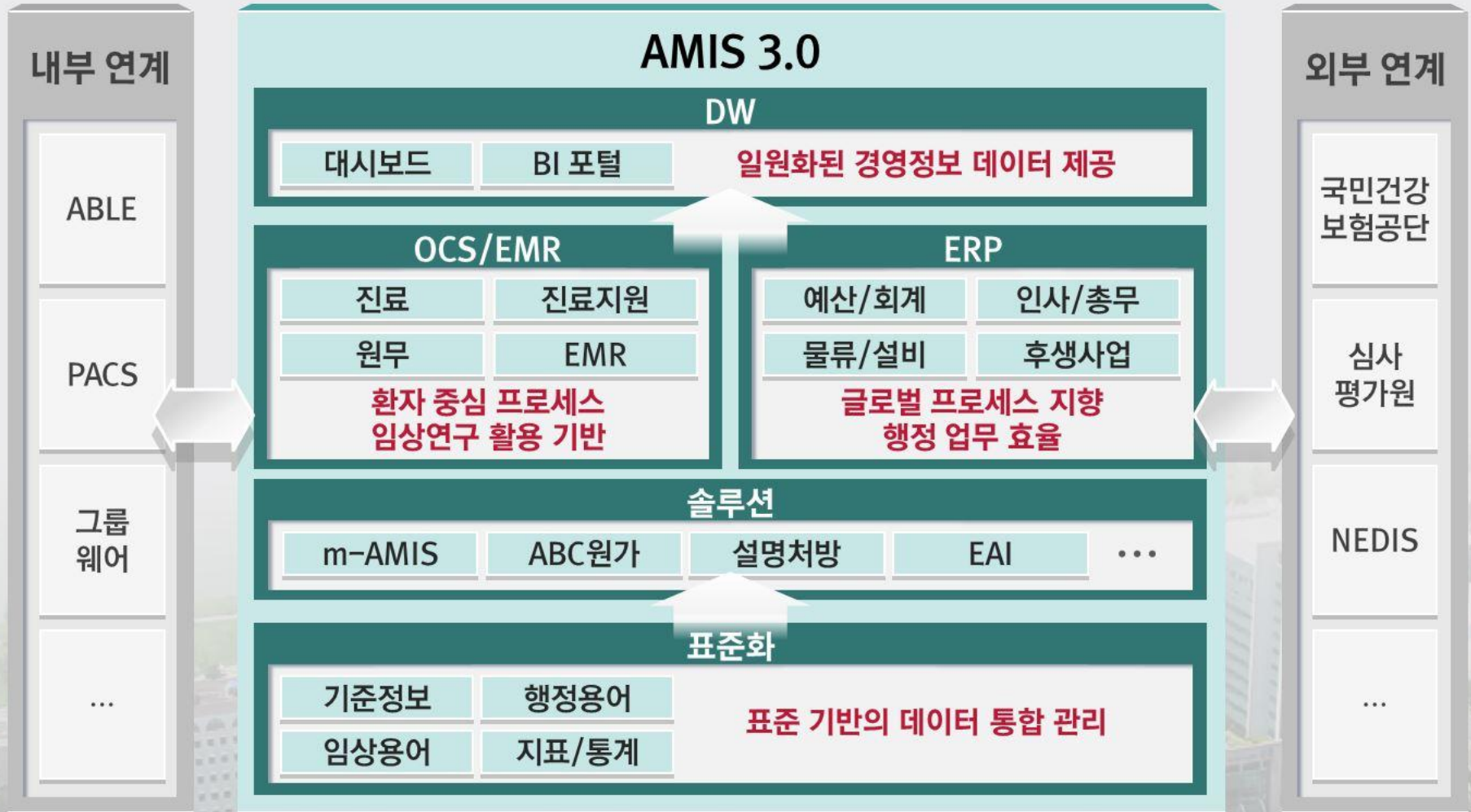
진료, 연구, 교육 및 관리 등 병원 전체 부문에서 실시간 상호 업무 연계와 정보공유가 가능한 사용자 중심의 통합의료정보시스템을 재구축하여 신속한 업무 처리와 의사결정이 가능하도록 하는 것

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



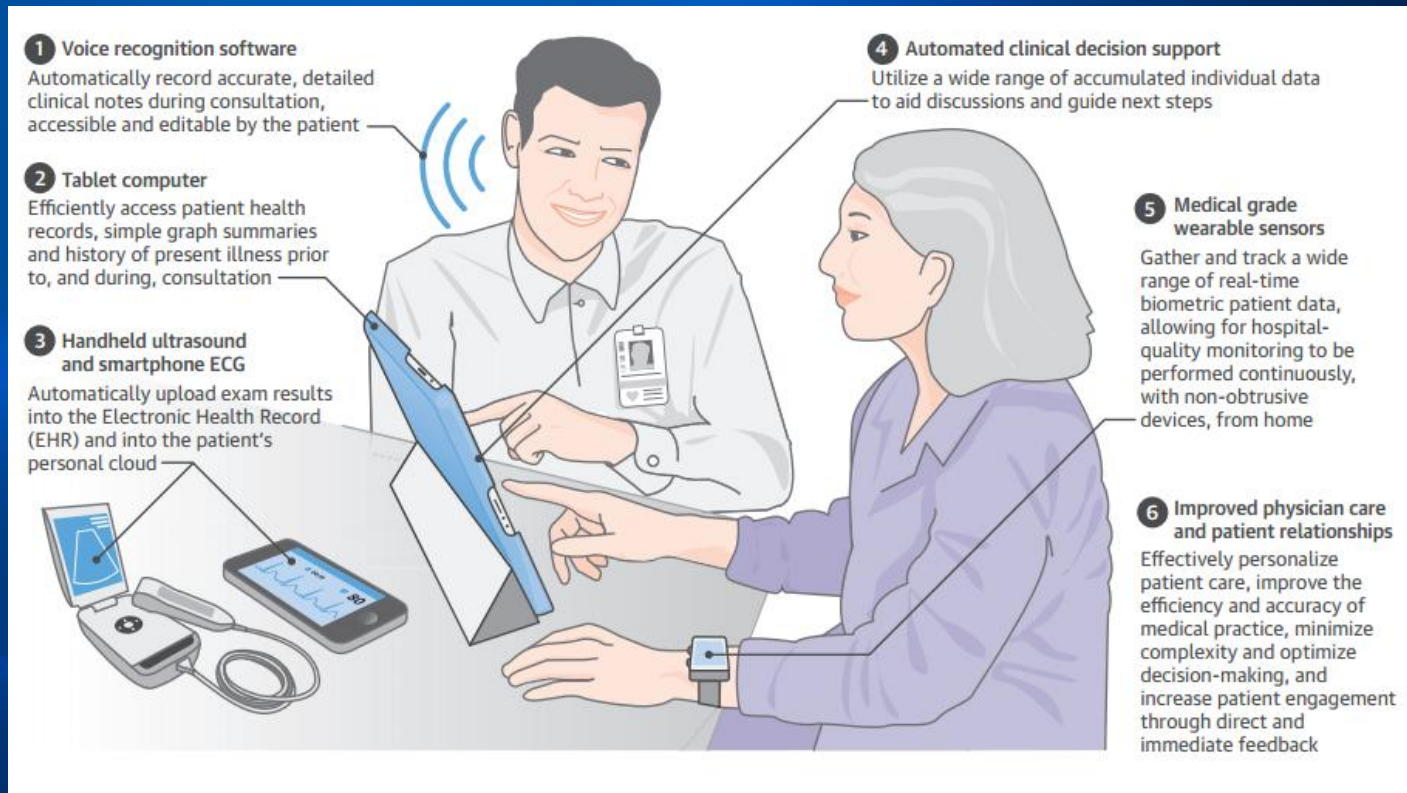
Device / remote Monitoring

- 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

Dr. M Project by KAIST with AMC

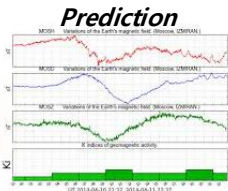
ICT system +
Medical care

- (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

Medical Assistance

Dr. M process

[6] Business model



[4] Disease diagnosis and prediction

Smart Sensors

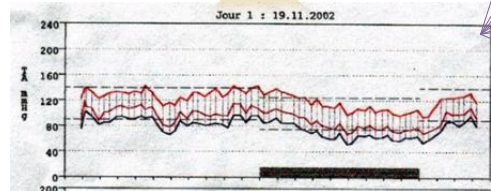
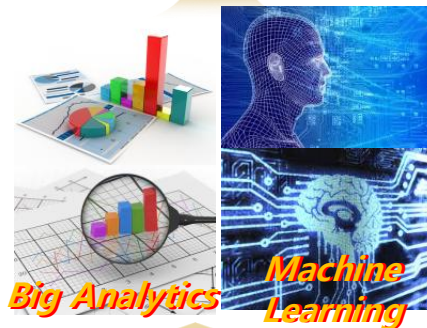
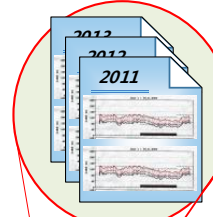
[1] biosignal sensing



Disease knowledge

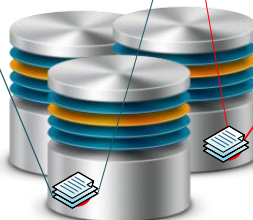
RESEARCH/DISEASE AREA	PY2011	81640 RAN
1. CANCER	7523	
2. PREVENTION	5655	
3. MICROBIOLOGY	5053	
4. NEUROSCIENCE	4933	
5. HEART AND CARDIOVASCULAR	4147	
7. WOMEN'S HEALTH	3864	
8. HUMAN DISORDERS	3864	
9. HUMAN/ENVIRONMENTAL SCIENCE	3593	
10. RARE DISEASES	3337	
11. INFECTIOUS DISEASES	3283	
12. BIOGEOGRAPHY	3277	
13. HIV/AIDS	3260	
14. POLYMER	3213	
15. HEALTH DISPARITIES**	2912	
16. ASIAN	2912	
17. STEEL I. DEPRESSION	2906	
18. MINORITY HEALTH	2554	
19. MENTAL HEALTH	2210	
20. EMERGING INFECTIOUS DISEASE	2100	
21. SENIOR MEDICINE	1920	
22. BIOPHYSICS**	1833	
23. IMMUNIZATION	1720	
24. VACCINE AREA TOP	1717	
25. ONCOLOGIC DRUGS	1668	
26. NEURODEGENERATIVE	1632	
27. SUBSTANCE ABUSE	1620	
28. NUTRITION	1411	
29. DISEASE OF THE LUNG (first cancer)	1249	
30. HEALTH SERVICES	1172	
31. DIABETES (TYPE 1 AND 2)***	1078	
32. DERMATOLOGIC RADIOLOGY	1071	
33. DRUG ABUSE	1053	
34. HEMATOLOGY	1036	
35. AUTOIMMUNE DISEASE	820	

Historical Data



Real-time Monitoring Data

[5] Identification of new medical knowledge



DrM Database

[3] IoT platform and data analysis

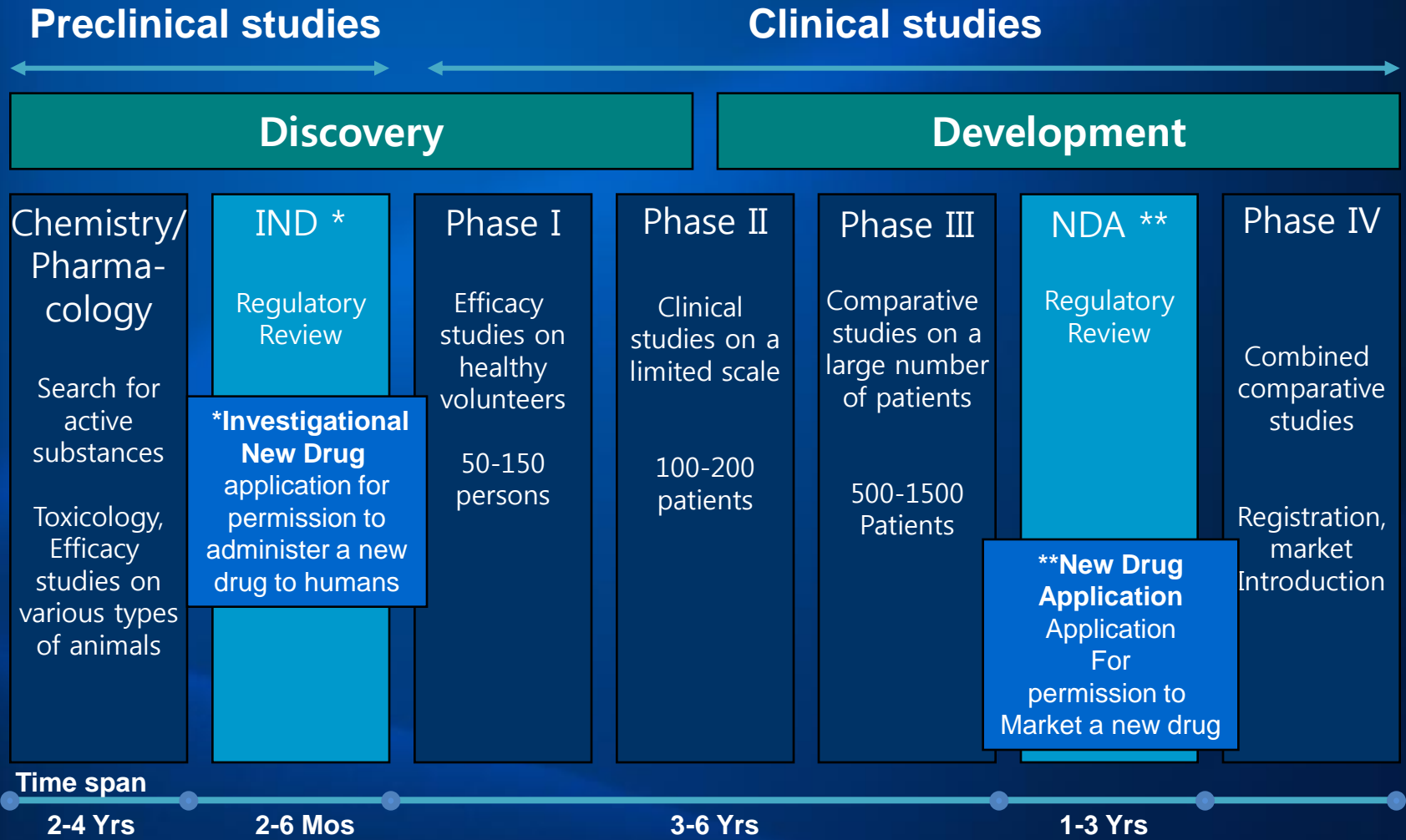
[2] low-voltage transmission, IPv6

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

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 failure

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.

Issues for Medical Big Data Utilization

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



Multicenter EMR, Public DB

- ✓ 심혈관질환 데이터 항목 정의 및 수집



- ✓ 청구 및 건강검진 데이터



Lifelog DB

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



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



Data Gathering → Data Analysis

Cardiovascular Healthcare Big Data Research

Clinical Validation ← Healthcare Big Data Platform



- ✓ 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**