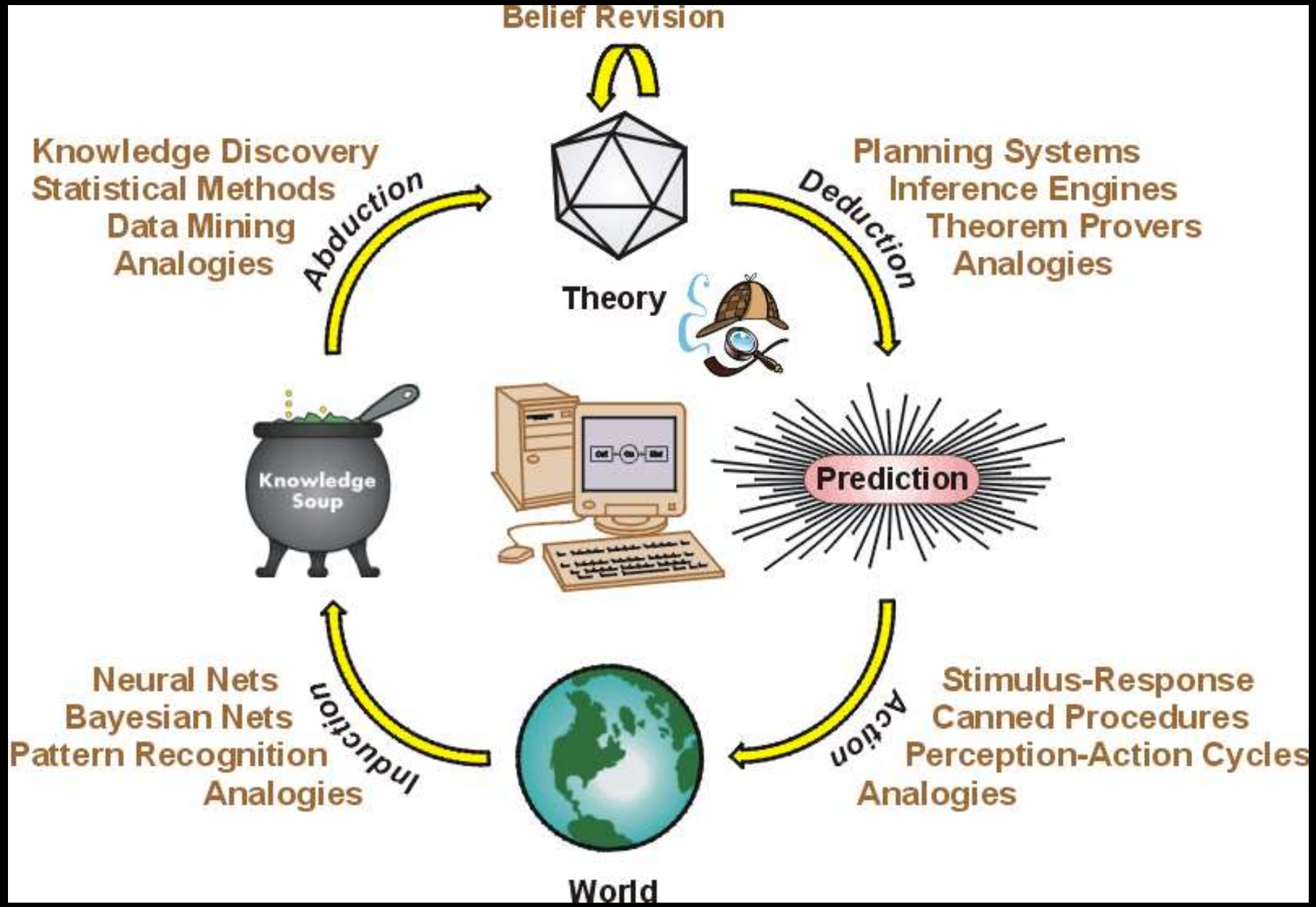
DECEMBER 2017

H2O WORLD 2017

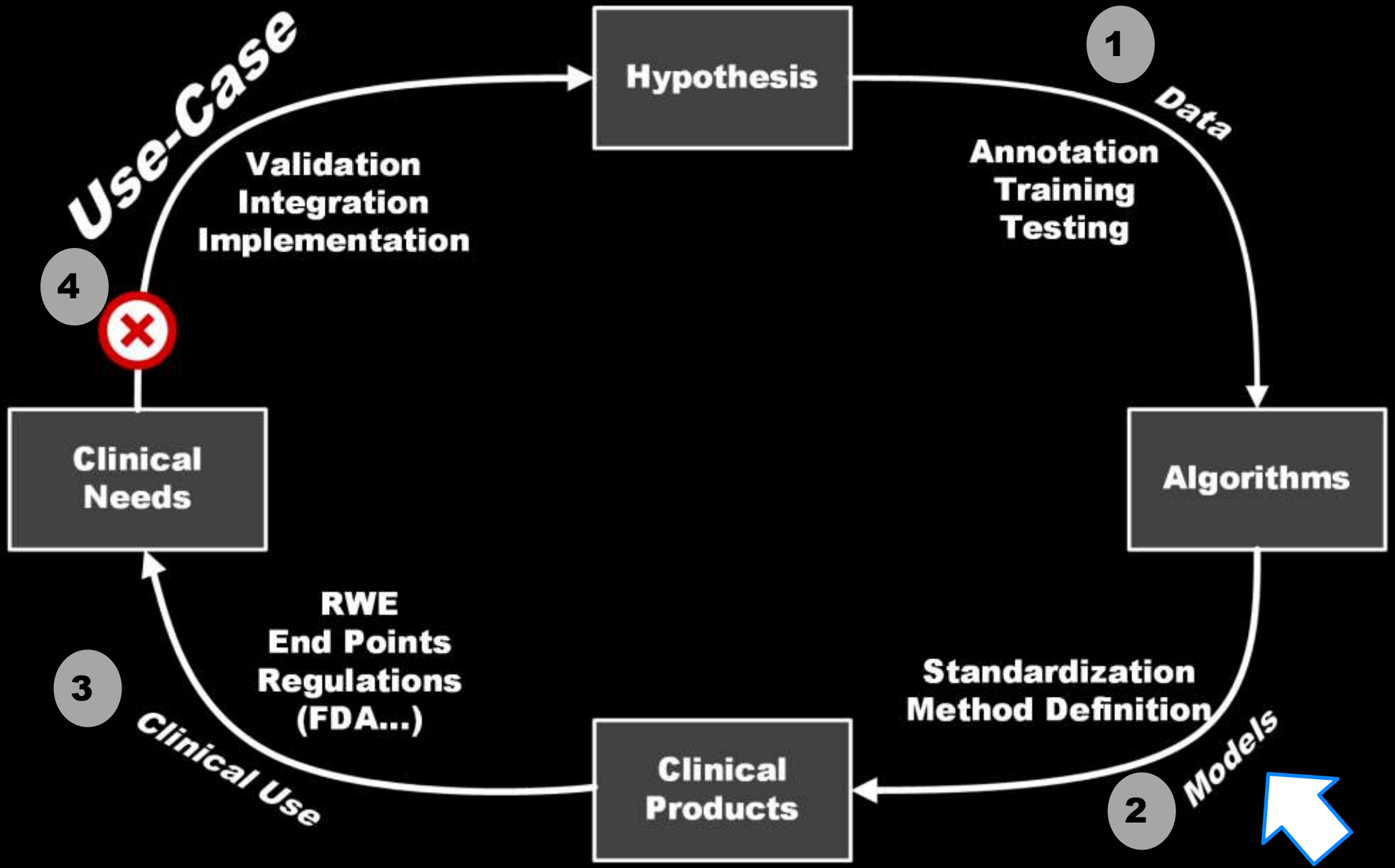
a 2017 *Healthcare and Life Sciences* Use-Case Retrospective

Sanjay Joshi



Knowledge Soup

Source:
http://www.jfsowa.com/talks/iccs03.htm



Clinical Knowledge Soup

USE-CASES

- ❑ Financial
- ❑ Operational
- ❑ Clinical
- ❑ Imaging

FINANCIAL

Hospital Readmissions

Patient Satisfaction

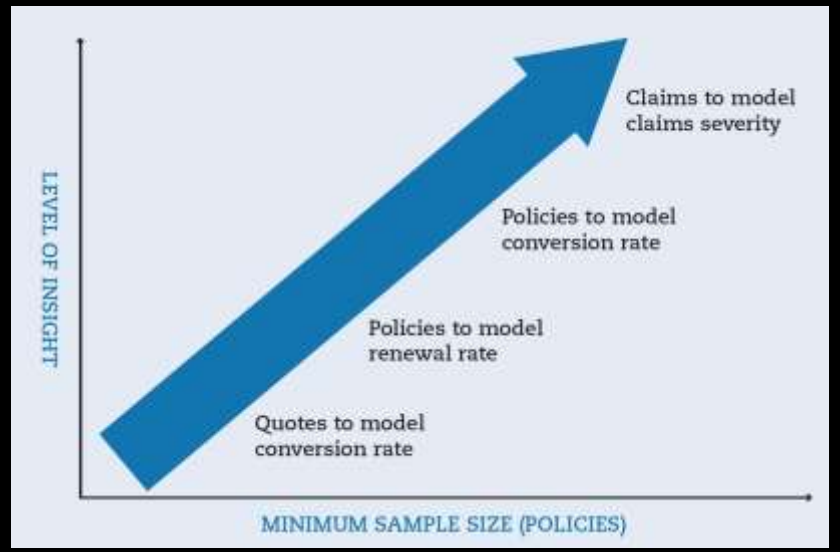
Physician, Nurse Burn-Out

Market Analysis

Patient Stratification

Physician, Nurse Calendar

Claims, Risk



Source: Brinkmann P, InsuranceERM Summer 2013

OPERATIONAL

Medical Errors

Rx Medication Reconciliation

AHRQ

MedDRA

FDA CDC

Regulatory Reporting

CCD Clinical Notes

Patient Satisfaction

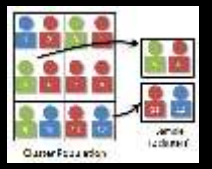
Patient Stratification

Patient Registries

Social Determinants

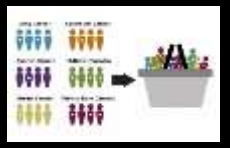
Prospective Randomized

Retrospective



Cluster Randomized

N-of-1

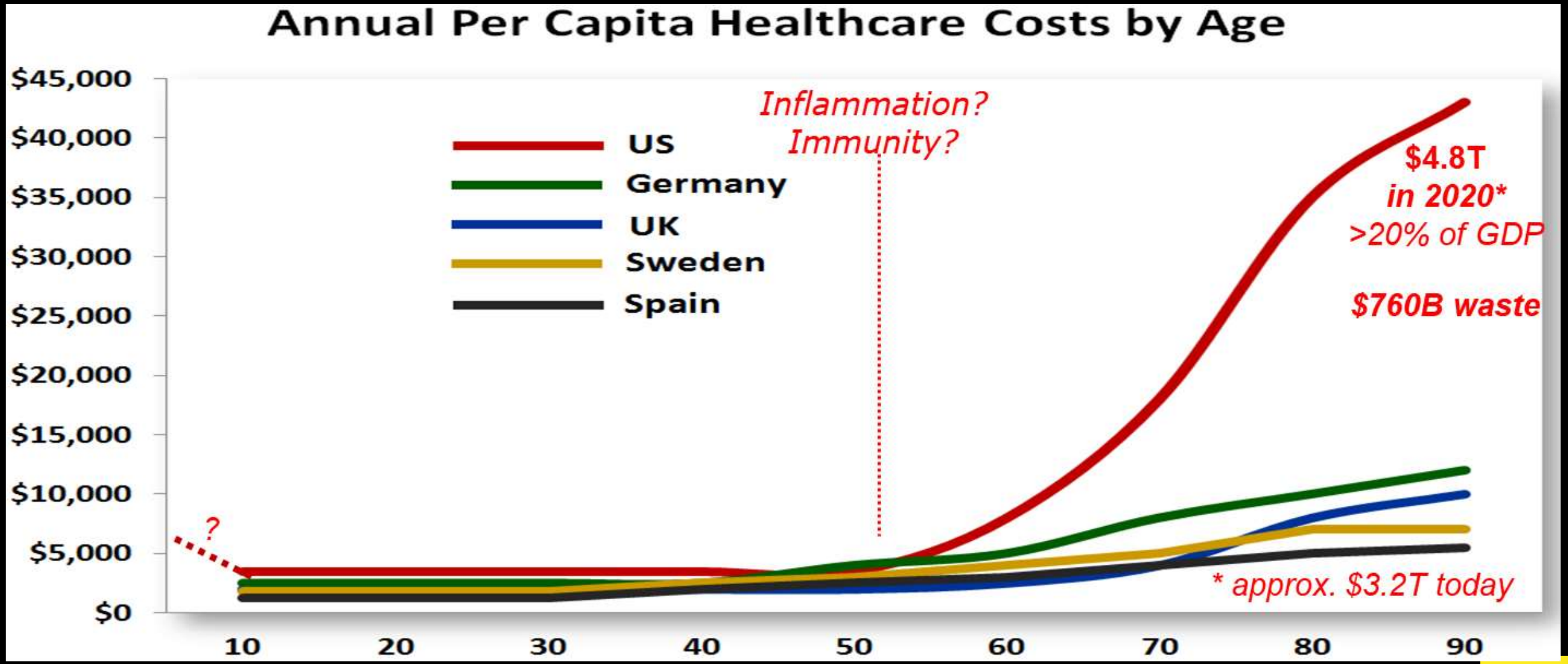


Basket, Umbrella

Clinical Trials

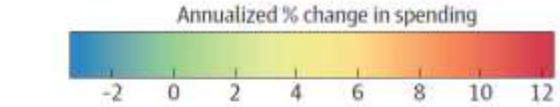
H2O.ai

CLINICAL



Derived from: Paul Fishbeck, Carnegie Mellon University, Research Report, 2009; CBO, 2013

Changes in Spending and Annualized Percent Changes for the 10 Health Conditions With the Largest Absolute Spending Increases, 1996-2013

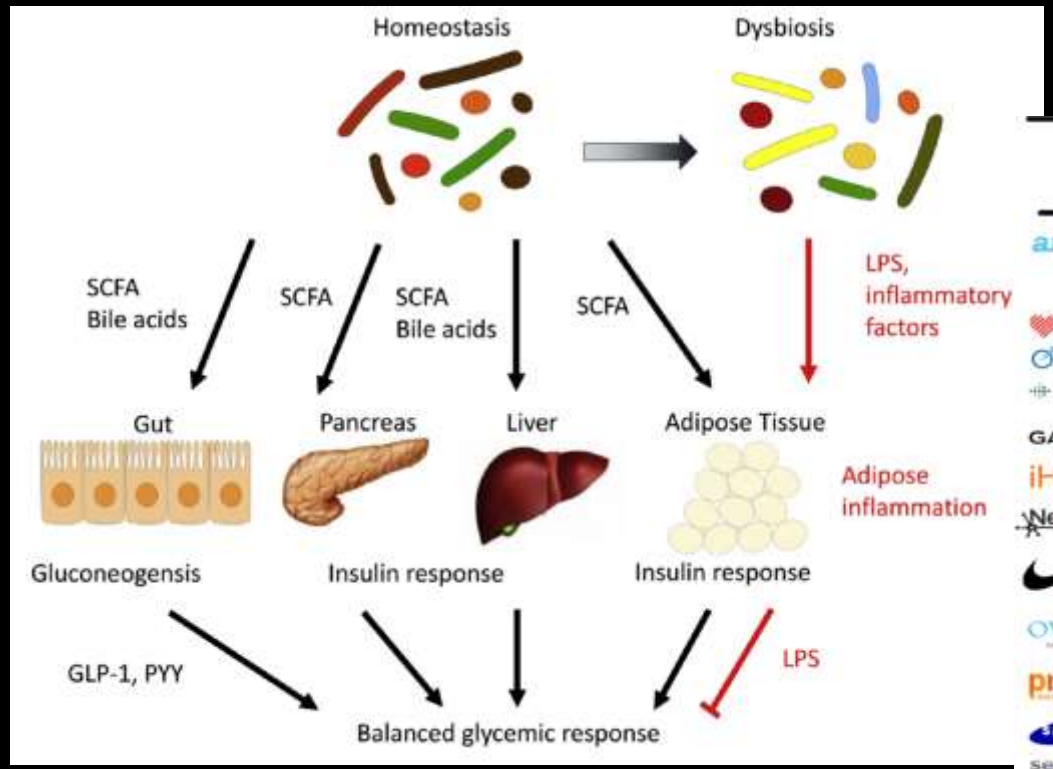


	Total Change, 1996-2013, $ Billions	Total Annualized % Change in Spending	Type of Care, Annualized % Change in Spending					Age Group, %		
			Ambulatory	Inpatient	Prescribed Retail Pharmaceuticals	Nursing Facility Care	Emergency Care	0-19 y	20-64 y	≥65 y
All causes	933.53 (933.52 to 933.53)	3.52 (3.52 to 3.52)	3.69 (3.69 to 3.69)	2.77 (2.77 to 2.77)	5.64 (5.64 to 5.64)	2.5 (2.5 to 2.5)	6.42 (6.42 to 6.42)	2.65 (2.4 to 2.89)	3.64 (3.58 to 3.7)	3.63 (3.55 to 3.72)
Diabetes	64.43 (57.88 to 70.61)	6.13 (5.29 to 6.95)	5.03 (3.63 to 6.49)	4.32 (3.28 to 5.82)	8.85 (7.14 to 10.62)	0.99 (0.26 to 1.51)	5.25 (3.22 to 7.48)	3.5 (2.55 to 4.48)	6.68 (5. 73 to 7.67)	5.6 (4.87 to 6.43)
Low back and neck pain	57.2 (47.38 to 64.4)	6.47 (5.25 to 7.74)	5.53 (3.89 to 7.24)	8.52 (7.14 to 9.59)	8.12 (6 to 10.16)	6.42 (5.18 to 7.81)	8.62 (6.73 to 10.55)	3.03 (1.67 to 4.5)	5.84 (4.57 to 7.16)	8.8 (7.7 to 9.94)
Hypertension[a]	47.59 (41.7 to 53.73)	5.06 (4.2 to 5.93)	6.92 (5.6 to 8.32)	5.24 (3.06 to 7.05)	4.77 (3.24 to 6.44)	0.71 (-0.18 to 1.25)	9.39 (7.25 to 11.66)	1.38 (0.08 to 2.41)	5.09 (4. 07 to 6.1)	5.1 (4.26 to 5.97)
Hyperlipidemia[a]	41.94 (37.7 to 45.37)	10.28 (8.87 to 11.62)	10.27 (8.57 to 11.95)	3.26 (0.8 to 4.92)	10.42 (8.73 to 12.1)	3.9 (1.75 to 7.13)	4.01 (3.41 to 4.54)	1.76 (-1.7 to 6.58)	9.13 (7.74 to 10.56)	11.97 (10.44 to 13.6)
Depressive disorders	30.83 (25.33 to 36.79)	3.41 (2.76 to 4.08)	3.62 (2.74 to 4.63)	-1.32 (-1.87 to -0.77)	6.84 (4.86 to 8.92)	0.87 (0.11 to 1.51)	7.02 (4.15 to 10.16)	2.7 (1.78 to 3.56)	3.68 (2.98 to 4.43)	2.34 (1.56 to 3.05)
Falls	30.4 (24.12 to 36.89)	3.04 (2.4 to 3.72)	4.39 (2.68 to 6.13)	1.81 (0.71 to 3.01)	0.57 (-1.56 to 2.72)	-0.06 (-1.15 to 1.2)	7.18 (5.89 to 8.61)	3.33 (2.34 to 4.43)	3.68 (2.69 to 4.57)	2.48 (1.84 to 3.32)
Urinary diseases	30.16 (25.84 to 35.29)	4.81 (4 to 5.73)	2.9 (1.45 to 4.37)	3.69 (2.67 to 5.19)	5.39 (3.23 to 7.76)	10.11 (8.75 to 11.59)	9.52 (7.62 to 11.36)	1.86 (0.83 to 2.93)	3.72 (2.83 to 4.66)	6.38 (5.52 to 7.32)
Osteoarthritis	29.86 (25.78 to 33.65)	5.92 (5.12 to 6.72)	5.42 (3.69 to 7.16)	7.69 (6.36 to 8.69)	3.75 (1.49 to 6.57)	0.22 (-0.58 to 0.74)	4.15 (-0.37 to 7.73)		5.92 (4.85 to 6.9)	5.93 (5.1 to 6.69)
Septicemia	25.95 (20.02 to 33.71)	8.91 (7.43 to 10.66)	-0.38 (-1.86 to 1.17)	9.23 (7.68 to 11.08)	-2.56 (-11.14 to 6.79)	3.97 (2.52 to 5.07)	3.81 (2.47 to 4.97)	4.88 (3.27 to 6.91)	8.11 (6.57 to 9.97)	9.56 (8.09 to 11.32)
Oral disorders	25.25 (17.42 to 33.16)	2.88 (1.83 to 4.15)	1.47 (-0.31 to 3.43)	4.3 (2.84 to 6.72)	0.69 (-1.46 to 3.55)	1.44 (-0.09 to 4.69)	9.64 (7.88 to 11.76)	1.11 (-0.18 to 2.53)	2.88 (1.83 to 4.15)	4.38 (3.1 to 5.71)

Source:
Dieleman JL, et al, "Factors Associated With Increases in US Health Care Spending, 1996-2013" JAMA. Nov 2017; 318(17):1668-1678. doi:10.1001/jama.2017.15927

Highest 18yr Cost Increase:

1. Hyperlipidemia
2. Septicemia
3. Pain
4. Diabetes
5. Osteoarthritis

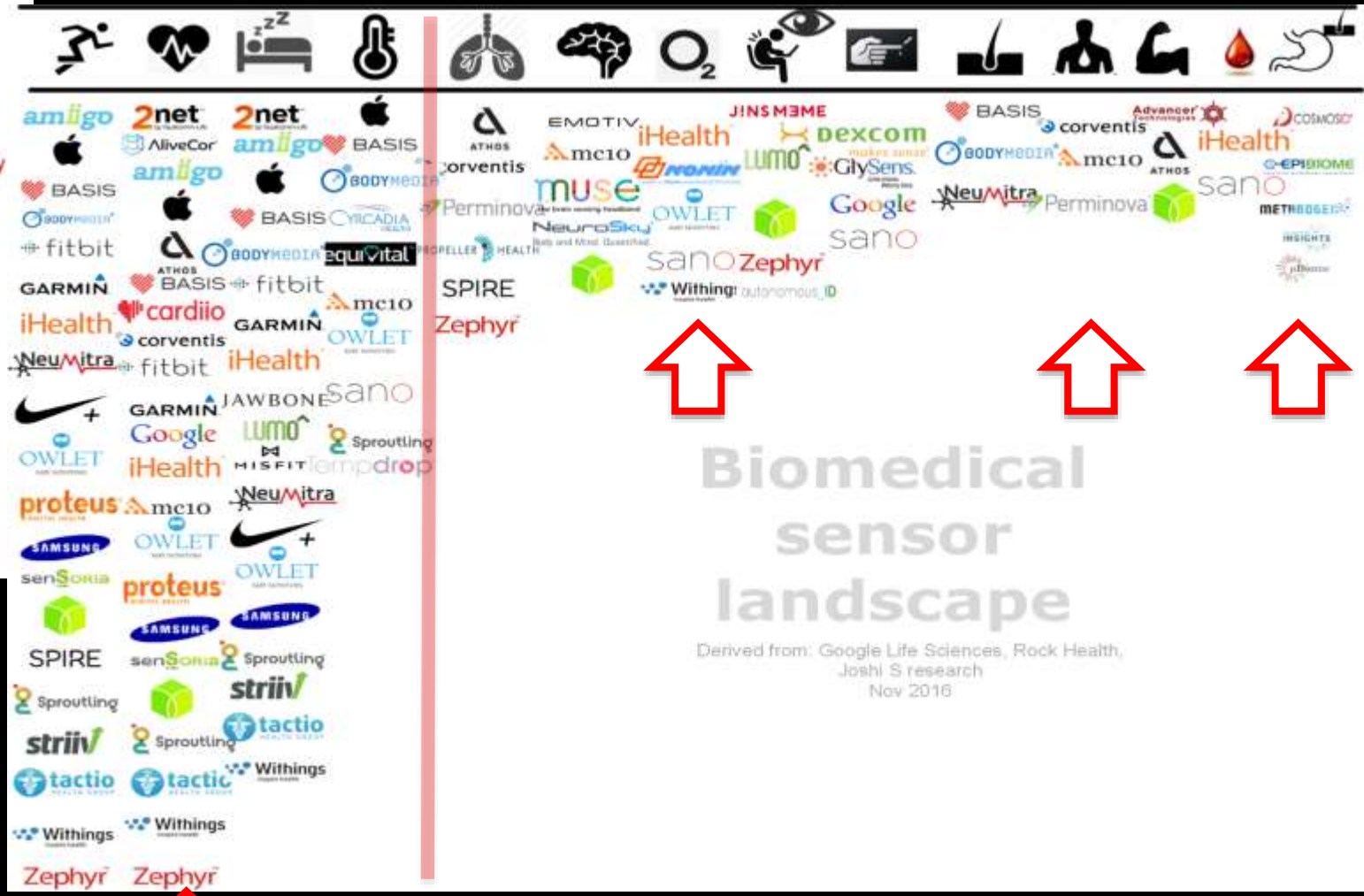


Source:
Suze J, et al, "Role of the microbiome in the normal and aberrant glycemic response", Clinical Nutrition Experimental 6 (2016) 59-73

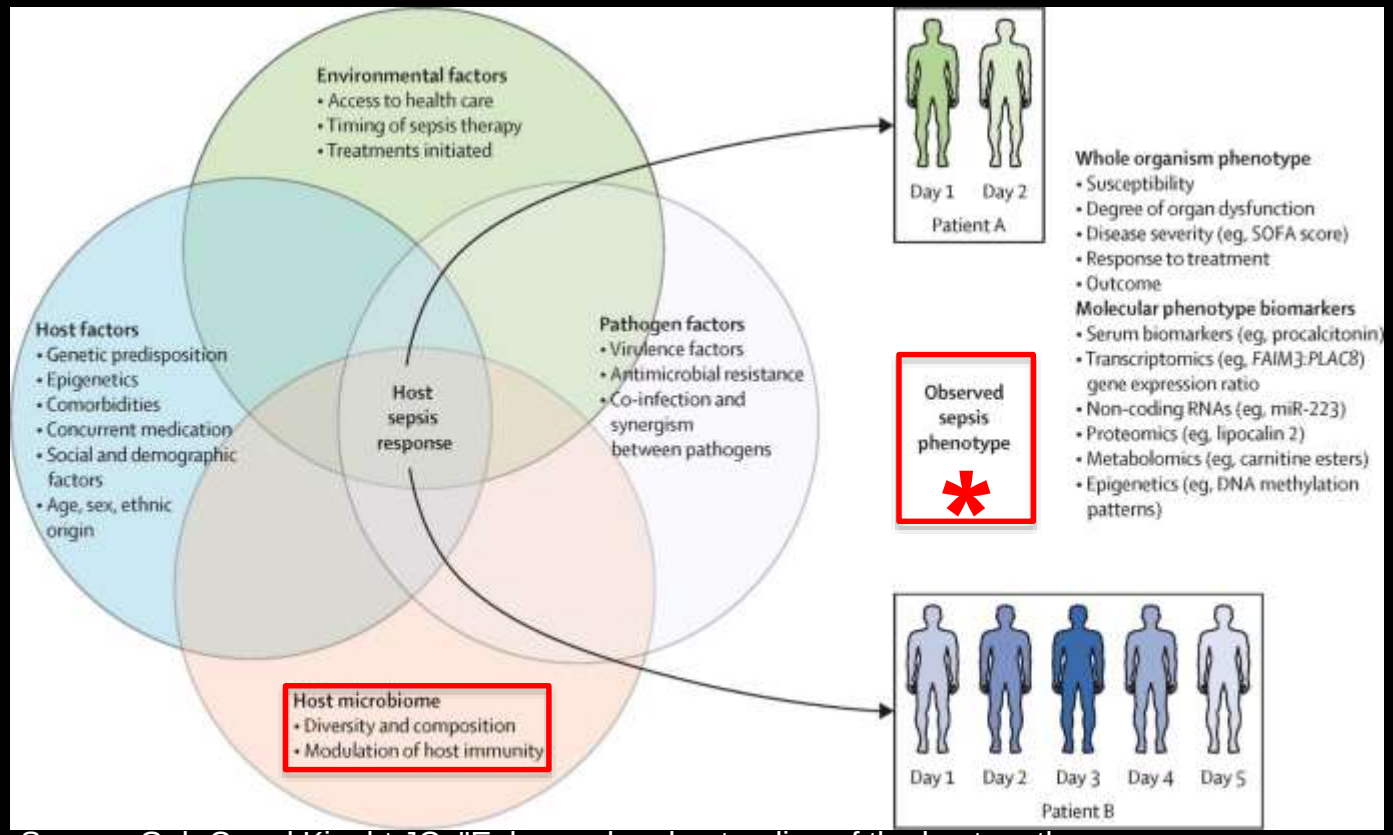
HYPERLIPIDEMIA

ML
(pathways)
+
time-series
(IoT + microbiome?)

IoT



AI on the Edge



Source: Goh C and Kinght JC, "Enhanced understanding of the host–pathogen interaction in sepsis: new opportunities for omic approaches", The Lancet Respiratory Medicine, Volume 5, No. 3, p212–223, March 2017

SEPTICEMIA

ML

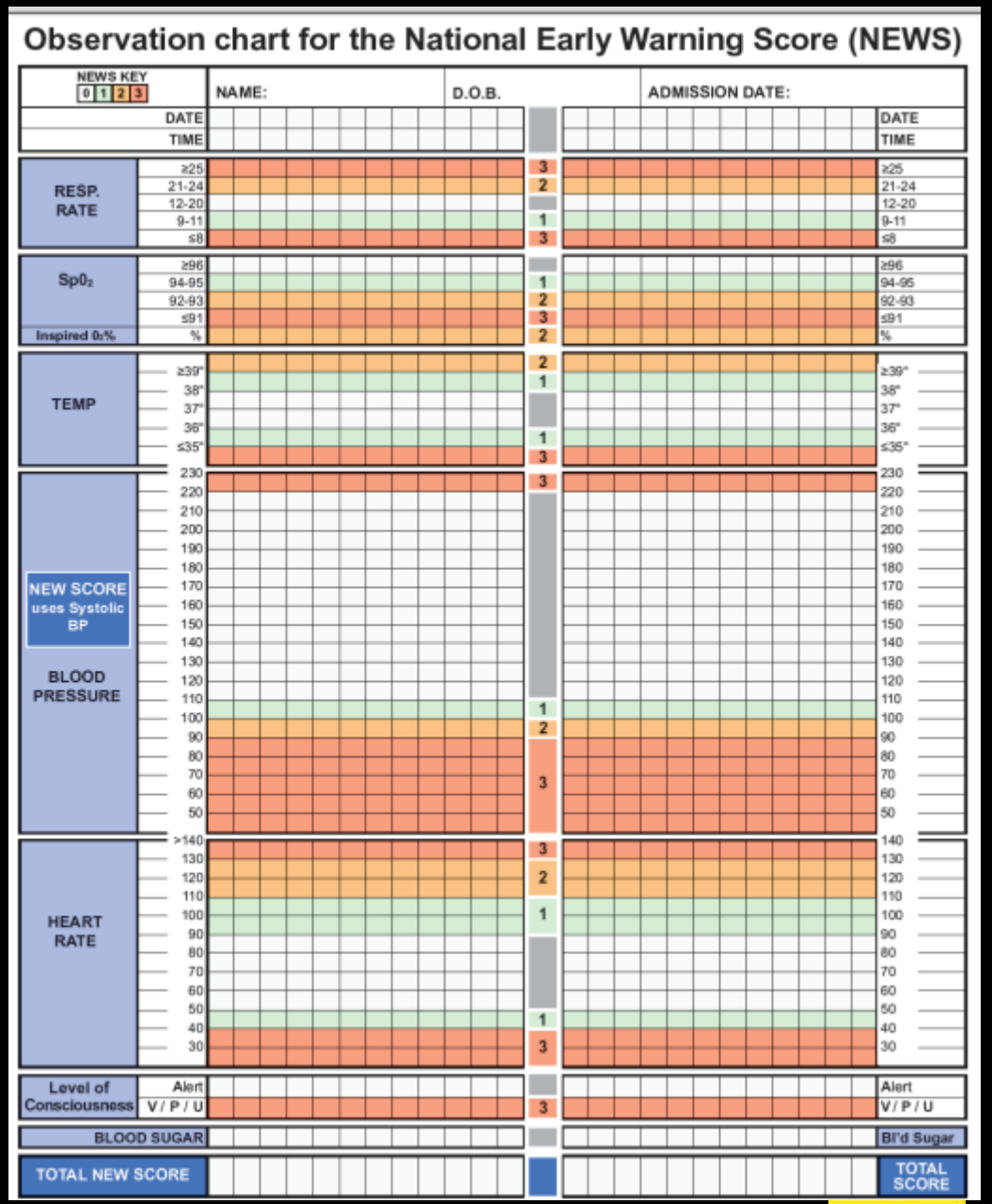
(NEWS + comorbid.)

+

time-series

(microbiome?)

* phenotype



Source:
Royal College of Physicians, "National Early Warning Score (NEWS): Standardising the assessment of acuteillness severity in the NHS.", Report of a working party. London: RCP, July 2012.

PAIN

PAIN ASSESSMENT GUIDE

TELL ME ABOUT YOUR PAIN

W ords to describe pain

aching	throbbing	shooting
stabbing	gnawing	sharp
tender	burning	exhausting
tiring	penetrating	nagging
numb	miserable	unbearable
dull	radiating	squeezing
crampy	deep	pressure

Pain in other languages

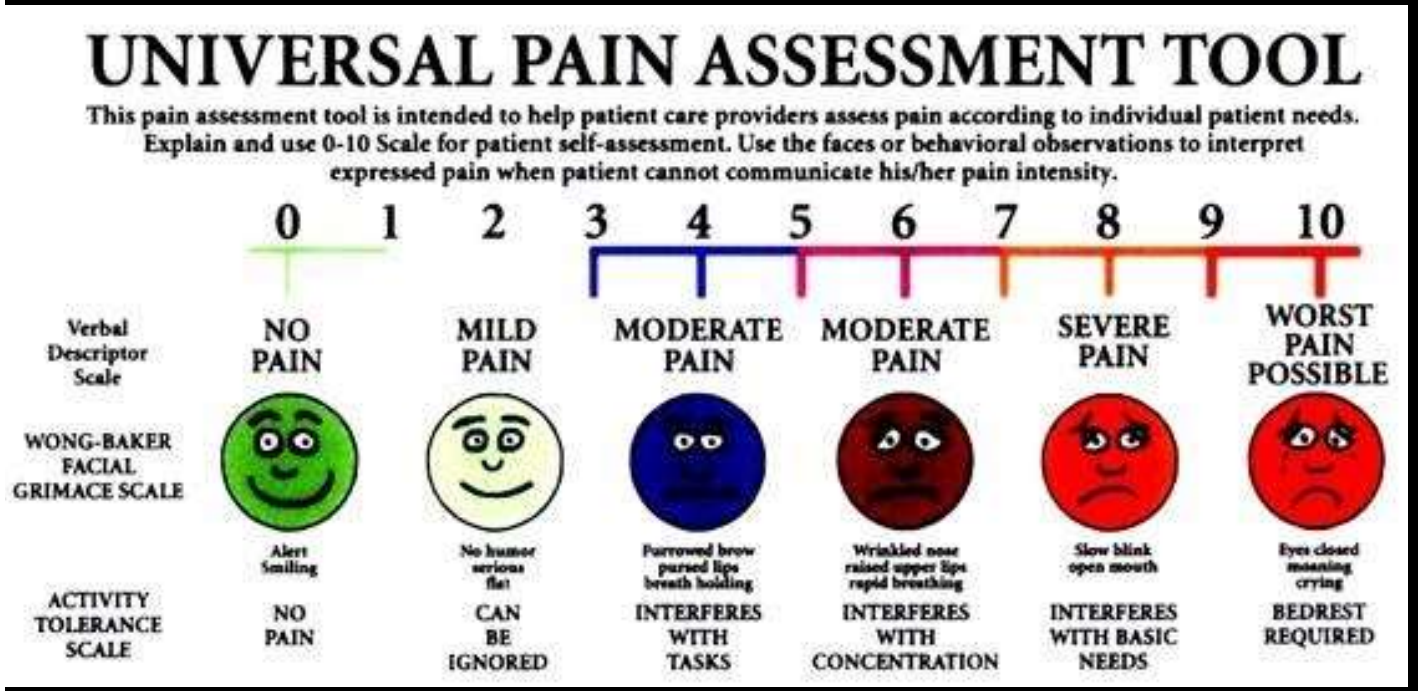
itami	Japanese	dolor	Spanish
tong	Chinese	douleur	French
dau	Vietnamese	bolno	Russian

I ntensity (0-10)
If 0 is no pain and 10 is the worst pain imaginable, what is your pain now? ... in the last 24 hours?

L ocation
Where is your pain?

D uration
Is the pain always there?
Does the pain come and go? (Breakthrough Pain)
Do you have both types of pain?

A ggravating and Alleviating Factors
What makes the pain better?
What makes the pain worse?



Sources:
Fink R, "Proceedings of Baylor Univ Med Center.", (2000 Jul); 13(3): 236–239.
Wong D, Whaley L. "Clinical Handbook of Pediatric Nursing.", 2nd ed. (1986) St. Louis, Mo: Mosby.

Opioid Overdose and Risks

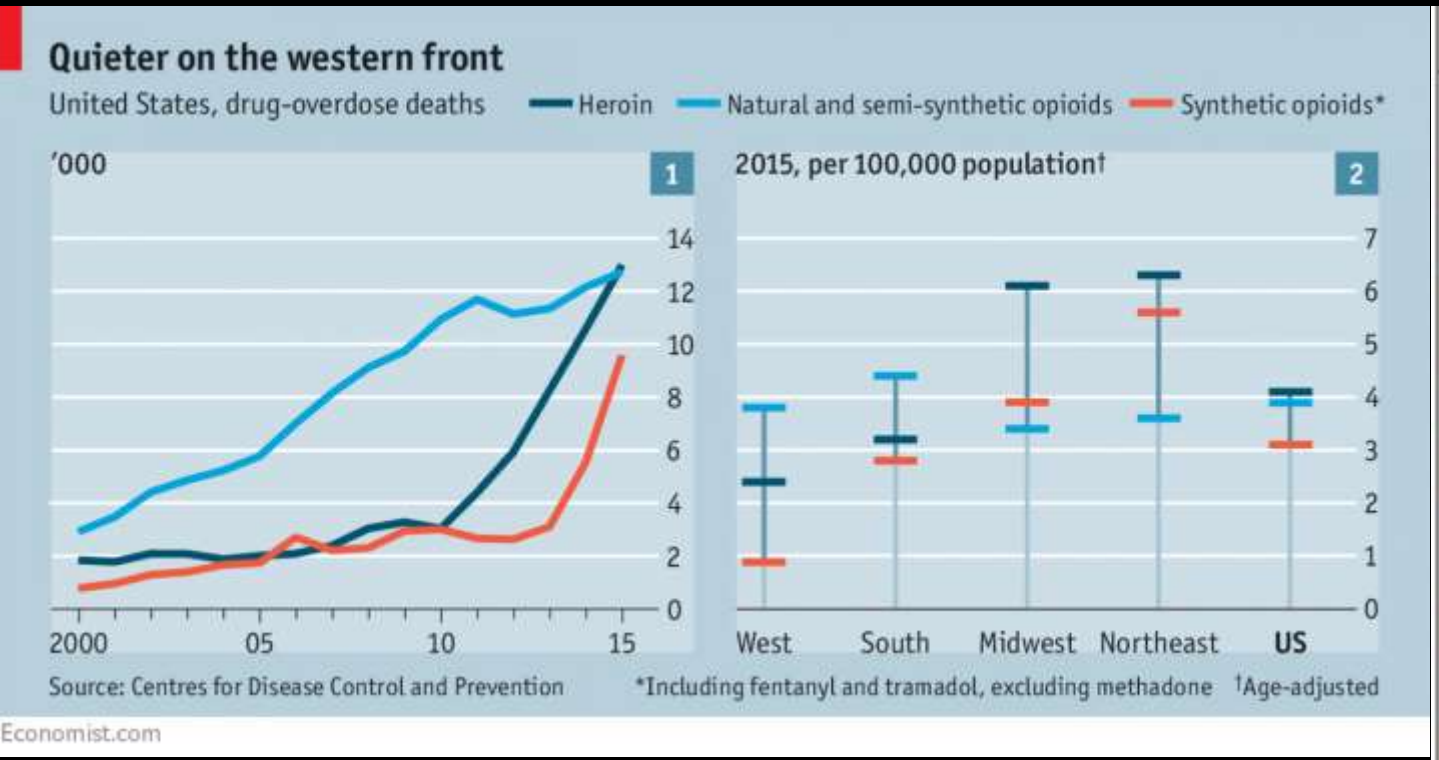


Table Factors Associated with the Risk of Opioid Overdose or Addiction.

Factor	Risk
Medication-related	
Daily dose >100 MME*	Overdose,[8] addiction[8]
Long-acting or extended-release formulation (e.g., methadone, fentanyl patch)	Overdose[14,41]
Combination of opioids with benzodiazepines	Overdose[42]
Long-term opioid use (>3 mo)†	Overdose,[43] addiction[44]
Period shortly after initiation of long-acting or extended-release formulation (<2 wk)	Overdose[45]
Patient-related	
Age >65 yr	Overdose[46]
Sleep-disordered breathing‡	Overdose[47]
Renal or hepatic impairment§	Overdose[48]
Depression	Overdose, addiction[49]
Substance-use disorder (including alcohol)	Overdose,[50] addiction[49]
History of overdose	Overdose[51]
Adolescence	Addiction[52]

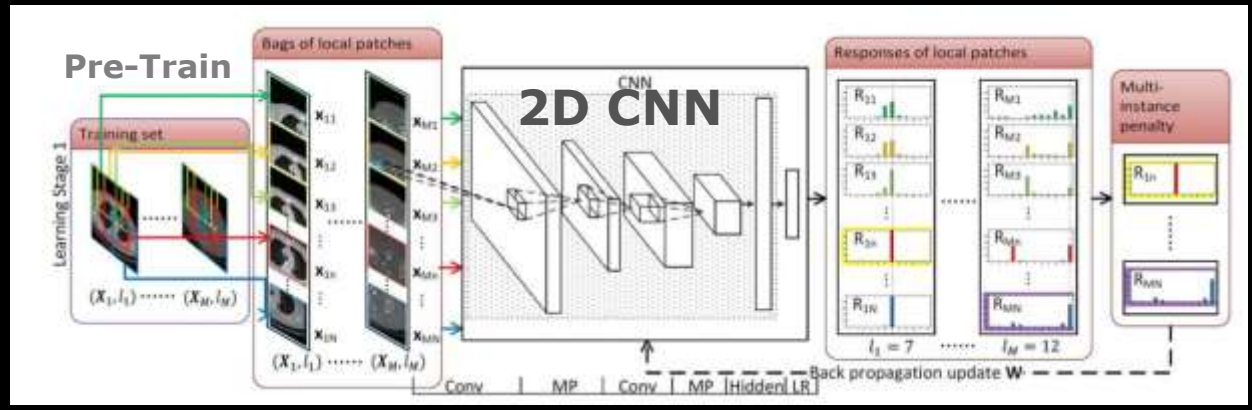
Sources:
The Economist, “Inside the Opioid Epidemic”, May 2017 https://www.economist.com/news/united-states/21721960-deaths-drugs-say-more-about-markets-about-white-despair-inside-opioid
Volkow ND & McLellan AT, "Opioid Abuse in Chronic Pain — Misconceptions and Mitigation Strategies", NEJM (2016); 374:1253-63. DOI: 10.1056/NEJMra1507771

Feature Engineering + Classification + time-series.

(also Fraud and Distribution)

IMAGING

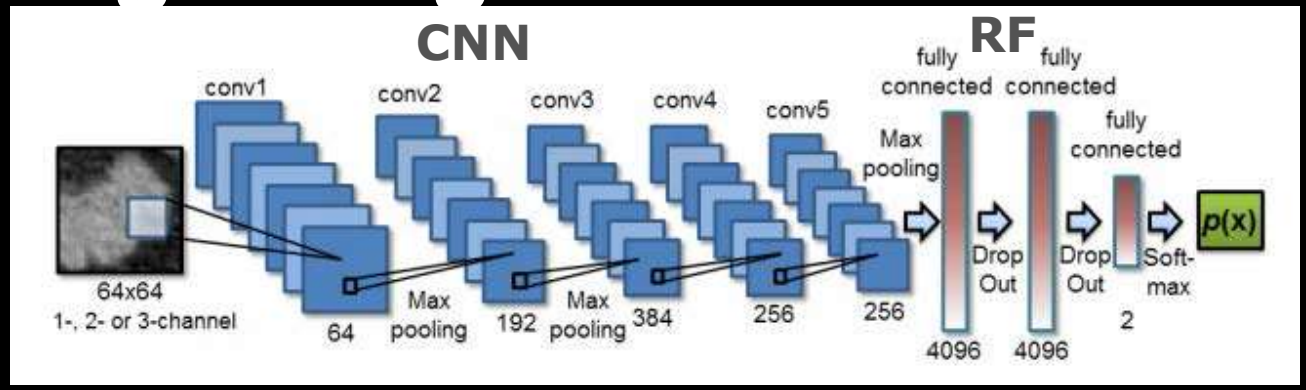
Anatomy Recognition



Source: Yan Z, et al. "Multi-Instance Deep Learning: Discover Discriminative Local Anatomies for Bodypart Recognition." IEEE trans on medical imaging 35.5 (2016): 1332-1343

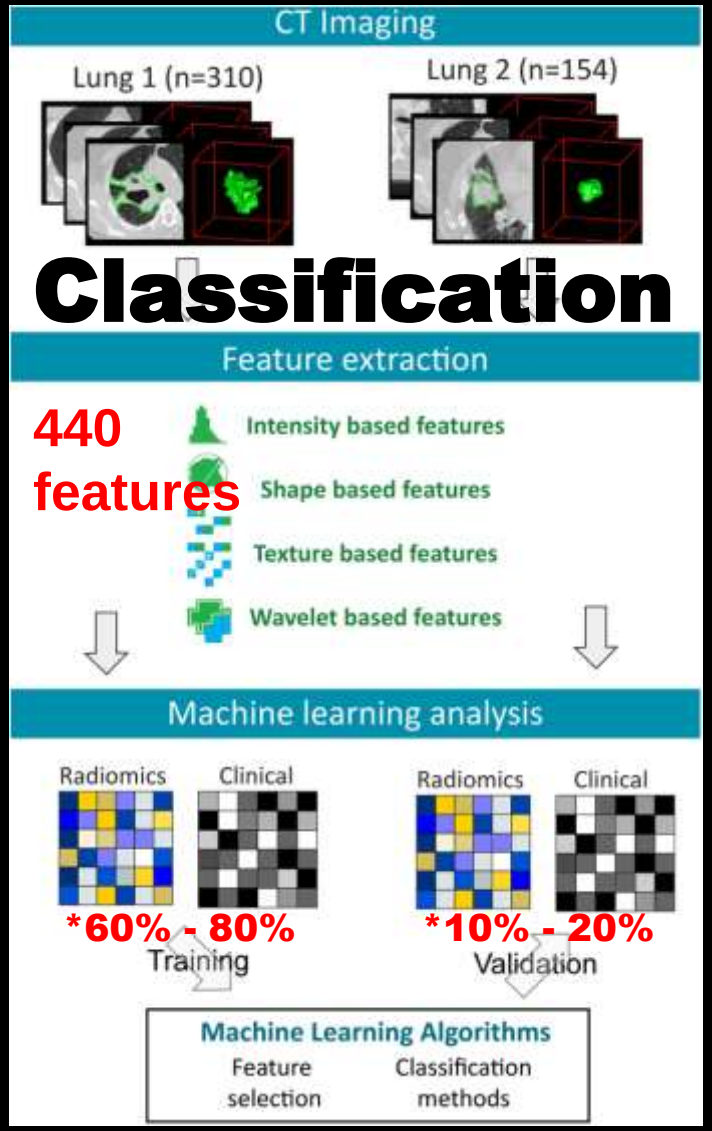
DL

Organ Segmentation



Source: Roth HR, et al. "DeepOrgan: Multi-level deep convolutional networks for automated pancreas segmentation." International Conference on Medical Image Computing and Computer-Assisted Intervention. Springer, 2015.

Classification



Source: Parmar C, et al, "Machine Learning methods for Quantitative Radiomic Biomarkers", Nature Scientific Reports, 5:13087, Aug2015

ML

*Source: Dr. Bradley Erickson, Mayo Clinic, RSNA 2017

Analytics Capability and Maturity Model

Level 8	Cost per Unit of Health Reimbursement & Prescriptive Analytics
Level 7	Cost per Capita Reimbursement & Predictive Analytics
Level 6	Cost per Case Reimbursement & Data Driven Culture
Level 5	Clinical Effectiveness & Population Management
Level 4	Automated External Reporting
Level 3	Automated Internal Reporting
Level 2	Standardized Vocabulary & Patient Registries
Level 1	Data Integration – Enterprise Data Warehouse
Level 0	Fragmented Point Solutions

Source: Health Catalyst
ignite outcomes improvement

STAGE 7	Personalized medicine & prescriptive analytics
STAGE 6	Clinical risk intervention & predictive analytics
STAGE 5	Enhancing quality of care, population health, and understanding the economics of care
STAGE 4	Measuring & managing evidence based care, care variability, and waste reduction
STAGE 3	Efficient, consistent internal and external report production and agility
STAGE 2	Core data warehouse workout: centralized database with an analytics competency center
STAGE 1	Foundation building: data aggregation and initial data governance
STAGE 0	Fragmented point solutions

Source: HIMSS

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AI for Health with Care

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